WORK PLAN

FORMER RARITAN ARSENAL
EDISON, NEW JERSEY
DACW41-89-D-0122, D.O.0006

PREPARED FOR
US ARMY CORPS OF ENGINEERS

DAMES & MOORE

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LIST OF ACRONYMS

OBG	O'Brien & Gere Engineers
TCE	Trichloroethene
T-1,2-DCE	Trans-1,2-dichloroethene
TNT	2,4,6-Trinitrotoluene
LEAD	Letterkenny Army Depot
MW	Monitoring Well
FBC	Federal Business Centers
VOC	Volatile Organic Compound
BNA	Base Neutrals and Acid Compounds (Semivolatiles)
DOD	Department of Defense
UXB	Unexploded Bombs International, Inc.
USACE	United States Army Corps of Engineers
CRL	Certified Reporting Limit
ND	Not detected
UXO	Unexploded Ordnance
TPH	Total Petroleum Hydrocarbons
MCL	Maximum Contaminant Level

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1.0 INTRODUCTION

The work described in this Work Plan involves the professional services necessary to begin a Remedial Investigation/Feasibility Study (RI/FS) at the former Raritan Arsenal in Edison, New Jersey. The intent of this study is to characterize and determine the extent of chemical contamination, including explosive-related contaminants in soil and water, in selected areas of the site; it is not intended to determine the presence of ordnance at the site.

Because of the complexity of the site, the fieldwork will be done in phases; the scope of the second phase will be dependent on the results of the first phase of sampling, and may include additional work to define the extent of contamination found during the first phase of sampling, or may include assessments of areas not previously studied.

1.1 SITE DESCRIPTION

1.1.1 General

The former Raritan Arsenal is located in Middlesex County, New Jersey, on the Banks of the Raritan River, approximately 20 miles southwest of lower Manhattan (see Figure 1). The former arsenal is bordered to the north and northwest by Woodbridge Avenue, and to the southwest by Millville Road and the ILR Landfill (see Figure 2).

Original land features at the site included marsh areas to the south and clay pits to the north. The topography of the site generally is flat; however, there is a sharp decrease in elevation at Woodbridge Avenue, most likely a result of cut-and-fill and clay pit operations.

The Raritan Arsenal site contains approximately 3,200 acres. Within the last 25 years, the northern half of the site has been developed extensively with the construction of industrial/commercial buildings and roadways. The southern half of the site has remained primarily marshland, with limited development since the arsenal closed in 1963.

Before the U.S. Army purchased the Raritan Arsenal site in 1917, the property consisted of farm land with several residences. The General Services Administration (GSA) sold 2,000 acres of the former arsenal to the Visceglia family in 1964; this family formed Federal Storage Warehouses. GSA then sold a parcel of land to Middlesex County, and the county developed

the area into Edison County Park and Middlesex County Community College. The redeveloped land on the former arsenal site is now mostly light industrial, warehouse, and office space in Raritan Center (2,000 acres); continuing development is occurring in this area.

1.1.2 Geology

The former Raritan Arsenal site is characterized by unconsolidated sediments unconformably overlying bedrock. Bedrock consists of red shale in the northwest part of the arsenal site and grades into a gray-black shale or slate to the southeast. Directly overlying bedrock is a silty clay layer varying in thickness from 4 to 8 feet. Overlying this silty clay layer are unconsolidated sediments composed of fine- to coarse-grained sand with varying amounts of clay and gravel. In the southern half of the site a black, clayey, organic peat layer separates the silty fine to coarse sands into two distinct layers above and below the peat. The peat layer terminates in the central area of the arsenal site, according to studies previously conducted at the site. Unconsolidated sediments below the peat are about 20 feet thick where the peat and clay deposits meet. In all, the thickness of unconsolidated sediments throughout the site ranges from 52 feet in the south-southeast to 20 feet in the north-northwest.

Ground water flow in the unconsolidated sediments throughout the arsenal is to the south and southeast, towards the Raritan River. Depth to ground water ranges from immediately below surface near the Raritan River to approximately 12 feet below grade in the northern section of the arsenal. The unconsolidated sediments above the clayey peat layer in the southern part of the arsenal compose an unconfined perched aquifer. Below the clayey peat, the aquifer is confined; it has a potentiometric surface above the bottom of the peat. Where the peat layer is absent, there is essentially only one unconfined aquifer.

1.2 BACKGROUND

1.2.1 Site History

The former Raritan Arsenal site was used extensively by the U.S. Army from 1917 to 1963. Operations at the site included the receipt, storage, shipment, and/or decommissioning of ordnance, arms, and machinery.

During this period some waste materials, including ordnance and chemical agents (mustard gas, red nitric acid, and miscellaneous chemicals), reportedly were buried on site. It also has been reported that explosive materials routinely were destroyed by surface burning or burning in chamber pits. Accidental explosions in magazine buildings and outdoor storage areas reportedly scattered explosive materials over large areas, and forced ordnance fragments into the ground.

1.2.2 Previous Field Investigations

Operations at the Raritan Arsenal were phased out between 1961 and 1963. Decontamination of the site was initially performed under the direction of Raritan Arsenal personnel in 1963, and later under the direction of personnel from the Letterkenny Army Depot (LEAD) and Army Material Command Safety Office. LEAD designated 17 areas as potentially contaminated in the study of 1963. Subsequently, the Army recommended that each area be designated either as "Unrestricted Use," "Surface Use Only," or "Non-Use," as deemed appropriate. Areas designated "surface use only" and "non-use" included pits possibly holding potassium cyanide and mustard gas containers, and areas which potentially contained live ordnance.

The New Jersey Hazardous Waste Facilities Siting Commission studied the undeveloped portions of Areas 2 and 3 to assess the feasibility of developing a hazardous waste incinerator at this location. As part of their study, the Commission installed three monitoring well (MW) nests (3-shallow, 3-deep) and two pairs of piezometers. The results of this investigation are not known.

O'Brien and Gere Engineers (OBG) of New Jersey, contracted by the U.S. Army Corps of Engineers (USACE), began a Contamination Evaluation Study in September of 1987. The objectives of the evaluation were to perform a field investigation and make a preliminary determination of whether chemical and/or ordnance contamination, which may have been caused by Department of Defense (DOD)-related activities, were present at the site. The 17 areas identified by LEAD were evaluated and prioritized during the development of the O'Brien and Gere work plan. The Army's 1963 Use Classification System and the risk posed by potential contaminants were used to rank the areas; additional criteria included results of previous studies and access for field activities. Following the ranking, a detailed order of priorities was established within each group. The primary criterion used was risk of direct exposure to

explosive materials, residues, chemicals, and contaminated soils, surface water, and ground water. This risk would be of concern mostly to investigation personnel, construction workers, children at play and, possibly, to employees of nearby businesses. The risk of exposure to contaminated ground water could not be discerned prior to the investigations and, therefore, was assumed to be equal for all contaminated areas.

The final report by OBG, submitted to the U.S. Army Corps of Engineers February 20, 1990, was entitled "Final Engineering Report, Former Raritan Arsenal, Contamination Evaluation, Edison, New Jersey, Project No. CO2NJ008400."

1.2.3 Results of Contamination Evaluation

OBG performed several tasks to complete the evaluation including:

1. Unexploded Ordnance (UXO) Survey
2. Magnetometer Surveys
3. Ground Penetrating Radar Surveys
4. Electromagnetic Surveys
5. Subsurface Exploration
   - A. Soil; Analytical/Geotechnical
   - B. Ground Water; Monitoring Wells
6. Surface Water Sampling

Geophysical surveys were performed in Areas 1 through 5, 7, 10, 11, and 16 based on their rank. Subsurface soil samples were collected by continuous split-spoon samplers to the designated 15-foot depth; a total of 32 soil borings were drilled. Generally, composite samples from 5-foot intervals were analyzed; analyses for volatile organic compounds (VOCs), however, were performed on discrete samples. Thirty monitoring wells were installed throughout the former arsenal, including 27 shallow wells and three deep wells. All shallow wells were installed to the first confining layer. Deep monitoring wells MW-31, MW-34, and MW-16 were installed within the confined aquifer. The selected chemical analyses were VOCs, metals (total and dissolved), petroleum hydrocarbons, and explosives. The OBG study and findings are summarized, for each area, in Section 2.0.

1.2.4 Current Investigations

The Huntsville Division of the U.S. Army Corps of Engineers is currently conducting ordnance-related investigations and removal operations at several areas of the site. Additionally, the USEPA is currently assessing the presence of contamination in their area; the results of the EPA study were not available at the time this work plan was developed.

2.0 SAMPLING LOCATIONS

In accordance with the Scope of Work provided by the U.S. Army Corps of Engineers, the following field work shall be performed as part of the Field Investigation:

1. Installation and sampling of 28 monitoring wells within and around the suspected areas of contamination;

2. Environmental sampling of soil in approximately 155 borings;
   - Approximately 890 soil samples

3. Sampling of water from each of 24 existing wells in Area 1 through 7, 9, and 11;

4. Surface water and sediment sampling from 9 locations in Areas 3, 4, 5, 6A, 8, and 11; and

5. Surface soil sampling in Area 11. Other areas will be visually inspected for surficial contamination during the Field Exploration Program; these areas include Areas 12 and 16.

6. Conduct a soil gas survey at approximately 300 locations (one point per location) to detect VOC concentrations; this survey will aid in the placement of monitoring wells and soil borings.

A UXO survey will be conducted to clear access routes, soil gas survey locations, and soil sampling and ground water monitoring well locations prior to any invasive activities. If anomalies are detected, no drilling will be performed in the suspect area. The location of the anomaly will be recorded by developing a sketch of the area; sufficient field measurements will

be made from prominent features to allow the anomaly to be located at a later date. The area also will be staked. Details of the UXO survey procedures are presented in a separate document titled Safety Plan Supplement for Former Raritan Arsenal, Edison, New Jersey, RI/FS (April 1991) by UXB International; this document is included as Appendix A.

All field work will be performed with strict adherence to the site-specific, Dames & Moore Health and Safety Plan. The safety plan is designed to help prevent accidents and exposure to hazardous materials, and to explain the proper action to be taken if these events occur. Field work will initially be conducted in Level D protection; however, if conditions warrant, an upgrade to Level C will occur.

A total of 28 monitoring wells will be installed during the Dames & Moore investigation. Water samples from these wells will be analyzed for volatile organic compounds, semi-volatile organic compounds, total metals, pesticides, and explosives. The locations of these new monitoring wells will be determined by the locations of existing wells installed by OBG, the analytical results obtained by OBG, and the results of a soil gas survey to be performed by Tracer Research Corporation, Inc. All existing OBG wells found at the site will also be sampled and analyzed for the parameters stated above.

In general, soil borings will be advanced to the depths shown in the following sections, or to the depth of ground water, whichever comes first. Contamination detected above the ground water level will be considered soil contamination; contamination detected below the ground water level will be considered ground water contamination.

The selection of analytical parameters is based on activities known to have occurred at the site, such as the deliberate or accidental demolition of explosives, on suspected activities such as the use of pesticides, and on the results of the OBG investigation. Based on the above, the selection of analyses for explosives and metals in these ordnance-related areas is obvious. Analysis for VOCs is indicated because this class of contamination was found in various ground water and soil samples analyzed by OBG. Analyses for semi-volatile organic compounds and pesticides is indicated because of the suspected use of these classes of chemicals for pest control and because of the extensive maintenance/refurbishing activities conducted at the site. With a few exceptions, soil samples from all areas of concern will be analyzed for VOCs, explosives and metals; additional analytical parameters may be selected based on the known or suspected

prior use of the area. Water samples throughout the site will be analyzed for VOCs, semi-volatile organic compounds, total metals, explosives and pesticides.

In general, the sampling locations are confined to the ordnance-related areas identified by LEAD in their 1963 study.

3.0 FIELD EXPLORATION PROGRAMS

3.1 SUBSURFACE SOIL AND UNEXPLODED ORDNANCE INVESTIGATION

UXB technicians will search all proposed soil boring and monitoring well locations. A geophysical survey by the following detectors will be completed:

1. Foerster Ferex Ordnance Locator
2. White's Commercial Metal Detector

Both are capable of detecting metals. A complete safety plan outlining the UXB procedures is included as Appendix A and is included in the Site Safety and Health Plan.

It is anticipated that UXB will clear access routes and proposed sampling locations prior to mobilizing the drillers to the site. UXB will be present during drilling activities to verify the absence of ordnance as the boring is advanced. UXB will also clear access routes and proposed sampling locations for the soil gas survey, and will be present during the survey to verify the absence of ordnance.

3.1.1 Drilling

To help ensure the safety of all field personnel, an ordnance survey will be conducted prior to drilling. The path to be travelled by the field technicians and the drilling rig will be searched for ordnance and other hazards by a UXB technician using an ordnance locator; the width of the path sweep is 15 feet. If ordnance is encountered, the location will be marked with stakes, recorded on a sketch, identified, and a clear route made around the ordnance.

At each boring location, a 60-foot diameter circle centered at the boring location will be searched for ordnance. If ordnance is discovered, a new boring location will be selected. Dames & Moore will report to the USACE all suspected areas of ordnance.

The UXB team will hand-auger the first two feet at each borehole location. A down hole search with the Foerster, assembled in the borehole mode, will help ensure that the borehole is clear of ordnance for the next two feet. Each 2 feet of drilling requires an ordnance scanning to the final depth of the boring; the 2-foot intervals correspond to the continuous sampling interval. If a significant metallic contact is discovered, the drilling site will be abandoned, the borehole location will be moved at least 10 feet, and the procedure will be repeated.

The choice of drilling methods is influenced by two main factors: (1) the need to minimize the introduction of foreign materials that may influence the results of analysis; and (2) the need to penetrate diverse geologic materials. Drilling for all phases of the field exploration program will be performed using a truck- and/or ATV-mounted drill rig. The ATV vehicle is designed for drilling in off-road situations where soft or marshy ground conditions may be encountered. The truck-mounted rig will be used in locations where soft or marshy ground is not a problem.

Shallow borings may be initiated with solid-stem augers or, if conditions warrant their use, by 6¼-inch hollow stem augers in non-self-supporting soils. A hollow-stem auger is basically a combination of casing and continuous helical augers, i.e., a hollow tube wrapped with a helical surface. The screw action of the auger is used to force the system into the ground. The bottom of the tube is filled with a plug; when the desired sampling depth is reached the plug is removed and the sampler is passed to the bottom of the borehole through the hollow stem.

If boulders are encountered, the hole will be grouted to the surface and another attempt will be made a few feet away, at the discretion of the field engineer.

Borings will be extended to depths specified in Section 4 of the Work Plan or to the depth of ground water, whichever comes first. These depths will be sufficient to obtain samples that will adequately characterize potential contamination present in the soils at the site.

3.1.2 Sampling

Each soil boring will be logged by an experienced Dames & Moore field geologist or engineer. A standard HTW Drilling Log, MRK Form 55 (June 1989) is shown in Figure 4. Information recorded on this log includes sample descriptions using the Unified Soil Classification System, boring location, drilling and sampling method, sampling interval, hammer blows per 6-inch advancement of the split-spoon, and pocket shear strength data. A copy of the Unified Soil Classification System is shown in Figure 5. All unusual characteristics observed during drilling activities, such as discoloration of soil, odors, or air monitoring results, will be noted in the field logs.

Many different types of soil samplers are available, and several different samplers may be used in a single boring. The type of sampler used depends on the subsurface conditions and the sophistication of analysis required for the proposed laboratory testing program. A description of the types of sampling tools that could be used during the investigation at the former Raritan Arsenal site is provided in the following two sections.

3.1.2.1 Standard Split-Spoon Sampler

A split-spoon sampler is so named because the main section of the sampler consists of a section of pipe that splits into two pieces along the axis of the pipe. A driving shoe and waste barrel screwed to the ends hold the split section together during driving. A diagram of the split-spoon sampler is shown in Figure 6. A sample is obtained by driving the sampler into the soil; the sampler, containing a soil specimen, then is removed from the borehole. The end connections are removed and the split portion is pried open to reveal the sample. The sample then is identified and placed in airtight storage containers. Aids for sample retention, including catchers, spring, or gravity traps (in the lower end) and check valves (in the top end), also may be incorporated in a split-spoon sampler.

The most common sampler is the 2-inch split-spoon sampler, which has been used to develop an empirical relationship between driving resistance and the relative density of the soil. The procedure for determining and interpreting penetration resistance or relative density is known as the Standard Penetration Test (SPT). A Standard Penetration Test is performed as follows:

1. A split-spoon sampler (outside diameter 2.0 inches; inside diameter 1.375 inches) attached to drill rods ("A" rod or larger, to prevent rod whip during driving) is lowered to the bottom of the borehole.

2. Three 6-inch increments are marked on the drill rods above a convenient fixed datum.

3. The sampler is driven by a 140-pound hammer free-falling a distance of 30 inches onto a collar on the drill rods. The sampler is driven a total of 18 inches into the undisturbed soil, and the number of blows required to advance each 6-inch increment is recorded.

The "blow count" for the SPT is the total number of blows required to drive the sample the last foot (i.e., the sum of the blows required to drive the sampler the second and third 6-inch increments). Erratic blow counts may be encountered in the last 6-inch segment due to a filled sampler, obstruction to driving, or a change in strata; if the erratic blow count can be explained by a factor other than a change in strata, twice the count for the second 6-inch segment may be used as an approximate SPT blow count.

Engineering correlations to SPT blow counts may be found in most soil mechanics textbooks. It must be remembered that depth, location of water table, and particle size affect the blow count, and appropriate evaluation of these factors is necessary.

3.1.2.2 Dames & Moore Type U Sampler

The Dames & Moore Type U Sampler is a drive-type split-spoon sampler with several improvements. The sampler, including bit, has an inside diameter of 2.42 inches and an outside diameter of 3.25 inches and consists of a waste barrel for disturbed soil, a split barrel with core retainer rings, and a cutting bit. A diagram of the Type U Sampler is shown in Figure 7.

Sampling with the Dames & Moore Type U Sampler is similar to other drive-type samplers. The sampler often is attached directly to the drill rods and lowered to the bottom of the hole for sampling. Three 6-inch increments are marked on the drill rods above a convenient datum on the drill rig. The sampler is driven into the ground, and the number of blows required for advancing each 6-inch increment is recorded. Most commonly, the Type U Sampler is

driven with a 300- or 340-pound hammer falling 24 inches. Field personnel will record the hammer weight and fall distance used during the sampling procedure.

In loose deposits, the Type U Sampler may be pushed (using drill rods) in one smooth stroke to help reduce disturbance. Under such circumstances blow count data would not be available.

After driving the sampler, the drill rods are withdrawn from the hole and the sampler is detached. The split barrel is separated from the waste barrel bit to reveal the brass rings that contain the sample, and the portion of the sample to be retained is selected.

The bit is checked after each sampling operation and replaced if it becomes burred or chipped. Filing burrs to smooth the bit will prolong its usefulness.

The decision to use the Dames & Moore Type U Sampler depends to a large extent on the type of soil being sampled. Relatively hard, insensitive soils (such as glacial tills), do not require the use of the Type-U Sampler. Soils containing coarse-grained material such as gravels can be sampled readily with a Type U Sampler.

While the Type U Sampler's weight, size, driving energy, and means of transmitting energy are different from the SPT Sampler, blow count information still can be significant. Variations within a particular boring provide insight into consistency, relative density, and stratus changes. Similarly, correlations between borings can be made across a site, and useful engineering conclusions can be drawn.

3.1.2.3 Care During Sampling

The care used in sampling techniques directly influences the laboratory test results, the engineering analyses, and the validity of the resulting recommendations. The following guidelines will be observed during sampling:

1. The drill bit must be of sufficient size to allow free passage of the sampler as it is lowered to the bottom of the borehole. If the boring is too small, material from the side wall will be scraped into the sampler.

2. The hole must be open to the last depth drilled before the next sample is taken. When the hole is open, the bit of the sampler (without predriving) should be at the last depth drilled. If a cave-in has occurred and/or cuttings have settled to the bottom of the borehole, this extraneous material can be removed by capturing it in the sampler; a clean sampler then is used to take the sample.

3. The hole should not be drilled to the sample depth and left overnight before a sample is taken. This procedure will be followed: (1) Take a sample at the end of the day, and (2) At the beginning of the next day, drill to the next sample interval and take a sample. This procedure helps eliminate pressure release expansion of samples.

4. If the sampler is being used below the water table, lower it slowly through the air-water interface. Rapid lowering will often dislodge the "doughnut" and permit the sample retainer leaves to spread prematurely. Pre-spread leaves often do not fold back into the retaining ring properly, causing extra soil disturbance.

5. Always know the depth of the borehole. The field engineer or geologist should know the length of rods and bit or sampler in the hole. The depth is then calculated by subtracting the amount of "stick-up" from the ground surface from this total length. By constantly knowing the depth of the borehole, the depth of change in drill speed, a change in the color of drill water, or other indications of strata change may be noted and properly logged.

6. If a sample is "missed" (lost or not obtained for any reason), the boring should be cleaned out by drilling about 6 inches below the unsuccessful sample depth prior to resampling. The sampler should be cleaned thoroughly and checked for clogged vents and other malfunctions that might have caused the "miss."

7. When taking any form of thin-wall samples, it often is helpful to allow 1 or 2 minutes to pass after advancing the tube and before pullout. This allows the sample to rebound slightly and more firmly adhere to the inside of the sampling tube, thus decreasing the possibility of incomplete or zero recovery. The sampler also may be rotated through several complete rotations which will generally shear the soil at the bottom of the tube.

3.1.2.4 Sample Labeling

Improper sample labeling can result in misleading laboratory data.

For proper field and lab identification of samples, the samples will be labeled by the following method:

Complete information for each sample will be written by the Field engineer/geologist on a standard circular tag which is affixed to the top of the sample jars. Circular tag information includes: (1) job number, (2) owner, (3) location, (4) boring number, (5) sample number, (6) depth interval, (7) date, (8) field engineer's/geologist's name, and (9) a description of the soil in as much detail as field evaluation permits. An example of the circular tag is shown in Figure 8.

3.1.2.5 Soil Boring Logs

The field Geologist or Engineer will fill out the boring logs in a complete, uniform, accurate, and legible manner using the standard HTW Drilling Log as shown in Figure 4. The procedures to be followed in completing boring logs are outlined below:

1. The identifying information at the top of the boring log must be filled in completely on the first page of the field log for each boring. The following information will be included:

    a. Job number
    b. Owner's name
    c. Job location
    d. Boring number
    e. Drilling contractor
    f. Operator's name (Name of the driller, number of helpers)
    g. Rig number
    h. Name of Field Engineer/Geologist, with last name spelled completely.
    i. Elevation and reference datum
    j. The location of the hole will be described, or a location sketch provided.

k. Water levels will be recorded. When using electric water level meters, the depth marks will be checked against an accurate tape measure. Water levels will be referenced to ground surface unless otherwise noted. The field personnel will identify a specific static water level at the conclusion of the boring. However, any questions about the water level having reached equilibrium will be noted.

l. The exact drilling and sampling methods used will be indicated, as well as the bit type and size, rod size, hammer weight and drop, types of samplers and type of drill rig. The weight and drop distances will be verified by the field personnel.

m. Surface conditions will be noted, including:
   (1) Vegetation or ground water and land use;
   (2) General topography (rolling, level, etc.);
   (3) Physical features (hillside, river bottom, etc.).

n. Sheet (page) number

o. The time and date of the start and conclusion of the boring. (All down time and end/start of shifts will be noted at the corresponding depth.)

p. PID (HNu) or FID (OVA) measurements from vicinity of borehole and/or samples, if applicable.

2. Each succeeding page of the field log will contain at a minimum:
   a. Name of field personnel
   b. Job number
   c. Client name
   d. Boring number
   e. Sheet number
   f. Any water level measurements

3. The following standard completion note will be included at the bottom of the last page of each boring log:

BORING COMPLETED AT _(depth)_ FEET ON _(date)_.
GROUND WATER LEVEL RECORDED AT _(depth_ FEET ON _(date)_.
HOLE GROUTED TO GROUND SURFACE ON _(date)_.
CASING USED TO A DEPTH OF _(depth)_ FEET ON _(date)_.

All depth numbers will be recorded in decimals.

4. The boring log will be filled out accurately and completely for each sample and sampling attempt. The following information will be included:

   a. The sampler type. The abbreviations for sampler types are TW for thin-wall, SS for standard split spoon, and U for Dames & Moore Type U Sampler. These abbreviations, or notations as to other sampler types, will be used in the "sampler type" column.

   b. The inches driven and recovered for each sample attempt.

   c. Note when casing was set and to what depth.

   d. The sample number and depth. The sample depth will always be measured to the top of the sample. A "missed" sample will not be numbered, but the fact that a sampling attempt was made will be noted.

   e. The blow count for each 6-inch interval recorded opposite the appropriate interval on the depth scale. If the spoon is pushed hydraulically rather than driven, this will be indicated.

   f. The number of rings of sample retained for each sample. If the sample is retained or kept in something other than the normal rings, the retaining device (bag, jar, thin-wall bit, etc.) will be noted in the "Number of Rings" column.

   g. The sampling attempts marked in the "depth in feet" column as follows:

      (1) A vertical line will be drawn through the sampling interval. Additionally, the sample depths will be marked with horizontal lines in column f.

      (2) For the Dames & Moore Type U, thin-wall, or other low-disturbance samples, the depth interval corresponding to the

sample will be blacked in completely if the sample is a testable, relatively undisturbed sample.

(3) A disturbed, untestable sample will be marked with an "X."

(4) For standard split-spoon samples, the depth interval corresponding to the sample will be half blacked in along a slanted line.

(5) A "missed" sample will be marked with an open box.

5. The log will contain a detailed description of the soil strata encountered and all pertinent information regarding drilling operations and estimated soil properties.

a. Soil will be classified according to the Unified Soil Classification System. A diagram of the system is shown in Figure 5. The Unified Soil Classification symbol (ML, CH, SP, etc.) will be written in the "description of materials" column within the depth interval corresponding to the appropriate soil type. The soil descriptions will be neat and orderly.

b. Abrupt soil changes will be marked by a solid horizontal line at the appropriate depth in the "description of materials" column. Definite gradational soil changes will be marked by a dashed line.

c. Soil color descriptions will be consistent with the Geological Society of America Rock or Musell Soil Color Chart.

d. Abbreviations will be used on the logs to save space for editing purposes. All abbreviations will be defined on the last page of each log.

e. Comments on the field log are extremely important. Some important aspects of the drilling operation that may be recorded include:

(1) The organic content of the soil and the depth of topsoil and roots always should be noted carefully. This is best accomplished by digging a small hole near the boring to more closely observe the depth of root matting.

(2) The shear strength of the soil will be estimated whenever possible. PSS stands for shear strength determination made with a pocket penetrometer.

(3) Any sudden change in the speed, sound, or penetration rate of the drill rig will be noted.

(4) Any sample that is suspected of being disturbed during the drilling process will be noted.

(5) Description of any tool drops, tool losses, or other such incidents.

(6) Depths and rates of water loss.

(7) Water/cement ratios used for grout.

(8) Reason for boring termination.

3.1.3 Grouting of Borings

Borings which extend to the depth of ground water will be grouted to the surface upon their completion. The purpose of the grouting procedure is to prevent the migration of foreign materials into the boring, and to prevent the potential migration of contamination to the ground water.

The grout will be introduced into the boring via a tremie pipe typically used for this procedure. This "bottom-up" procedure reduces caving and insures the complete filling of the boring.

The grout will consist of approximately 94 percent Portland cement and 3 percent bentonite; no more than 11.5 gallons of water per sack of cement will be used.

3.1.4 Head Space Analyses

Head space analyses will be performed in Areas 6A, 7, 11, 12, 14 and 17A to select discrete soil samples for VOC analysis. With the exception of Area 7 (the boreholes will be advanced to a depth of 10 feet in this area), soil borings are limited to a depth of 5 feet or to the depth of ground water, whichever comes first. The following head space analysis procedure will be used:

- For borings extending to a depth of 0 to 5 feet, samples for headspace analysis will be selected from depths of 0 to 2 feet and 3 to 5 feet.

- For borings in Area 7, samples for head space analysis will be selected at 2-foot intervals to the depth of the borehole.

- After the subsurface soil sample has been logged, the soil sample will be split using a stainless steel sampling knife. A portion of the sample will be placed into a 4-ounce glass container, completely filling the jar. This jar will be marked with a temporary identification number, and will be placed in an iced cooler.

- A portion of the remaining sample will be placed in a 16-ounce soil sample jar; sufficient material will be used to half fill the jar.

- The jar opening will be covered with aluminum foil and capped.

- The jar will be marked with the same temporary identification number as the full jar containing the other portion of the sample.

- The soil sample will be brought to a temperature of 20 to 32° C. for a period of at least 10 minutes. Depending on ambient conditions, this may require the half-full jars to be placed in a heated building or motor vehicle.

- After sufficient time has elapsed, the cap will be removed and the probe of an organic vapor analyzer will be pushed through the aluminum foil.

- The highest meter response will be recorded as the headspace concentration.

- The full, 4-ounce glass container, which corresponds to the highest head space reading, will be retained for chemical analysis. The remaining samples will be properly disposed.

- The 16-ounce sample jars used for the head space analysis will be decontaminated in accordance with the procedures stated in Section 7.2 and reused. New 4-ounce sample containers will be used at all times.

- OVA instrument calibration will be checked at least every 10 analyses or daily, whichever is more stringent.

3.1.5 Soil Sampling

Soil samples may be obtained as composites from 5-foot intervals (in areas where soil sampling has not been previous performed), or from 1-foot sampling intervals, as stated in Section 4.0. In areas where 5-foot composite samples will be obtained, such as Areas 11, 12, and 14, samples for VOC analysis will be selected based on head space analysis, retaining those samples which have the greatest evidence of contamination (i.e., the highest OVA reading). The selection of samples to be analyzed for semi-volatiles will be based on visual observations of the soils, such as staining or discoloration; if there are no visual signs of contamination, the sample analyzed for semi-volatiles will be a composite sample of the entire depth of the borehole. Soil samples will be obtained using a split-spoon sampler as described in Section 3.1.2

All sampling locations will be surveyed for the presence of ordnance; the following procedures then will be followed during soil sampling:

1. Set up the decontamination area, sampling preparation area, and support area near the borehole location.

2. Decontaminate all equipment, samplers, and tools that will come in contact with the soil.

3. Inform the driller of the sample interval(s) for the borehole, and oversee the sampling process.

4. Prepare and label the sample containers. Label the containers with the location, depth, date, and time of sampling.

5. Have the driller prepare the sampler for opening, but do not allow the driller to completely open the sampler.

6. Open the sampler slowly while it is lying on a clean sheet of plastic. As the sampler is being opened, the surface of the core should be "sniffed" with an HNu or OVA with the probe of the instrument about one inch from the sample. Record the instrument readings in the log book.

7. Log the core, recording percent recovery; color; texture; clay, sand, and gravel content; and other notable characteristics in the log book.

8. Obtain soil samples for VOC analysis first. Completely fill the sample jar to minimize the loss of volatiles.

9. Perform head space analyses on the soils where required (Areas 6A, 7, 11, 12, 14, 17A). Using a sampling knife or a stainless steel spoon, split the sample lengthwise, cut off pieces of the sample and place the pieces into a container until it is approximately half full. The remainder of the sample will be placed in a field sample jar; the jar will be labeled and temporarily placed in an iced cooler. Cover the opening of the container with aluminum foil, and screw the cap on the container. Allow the containers to reach a temperature of 20° to 32° C for at least 10 minutes. Unscrew the cap, insert the probe of the OVA through the aluminum foil, and obtain a reading. Record this reading in the appropriate place on the borehole log and in the field log book. The soil sample which corresponds to the highest head space reading will be retained for chemical analysis. Additional details are presented in Section 3.1.4.

10. Composite samples for analytes other than VOCs (such as metals, explosives, pesticides, PCBs) will be obtained by homogenizing equal portions of soil samples from each split-spoon sample. Using a sampling knife or stainless steel spoon, place pieces of the soils from the sampler into a stainless steel bowl and homogenize until a relatively uniform color and texture have been obtained. Fill the required number of sample jars with the homogenized soils, screw on the caps, and place the sample jars into an iced cooler for temporary storage and transport to the sample staging area.

11. Properly dispose of soil cuttings, wastewater, and waste generated during the decontamination process in accordance with procedures stated in Section 13.0.

3.2 MONITORING WELLS

A total of 28 monitoring wells will be installed within and around Areas 2 through 16. Water samples will be obtained to assess water contamination at the site. Generally, the monitoring well locations will be as shown on Plate 2. Copies of site-specific well specifications will be maintained at the drilling site by the New Jersey licensed well driller, Laura A. Brinkerhoff, Inc.

The location of the wells will be determined by conducting a soil gas survey. A total of five potential well locations will be assessed for each well installed; the boring location with the highest concentration of organic vapors will be selected for well installation. However, some wells, such as those installed primarily to detect explosives in the ground water, will be installed at predetermined locations after discussions with USACE personnel. The soil gases will be obtained by pushing a probe approximately 5 feet into the soils and extracting a vapor sample. These samples will be analyzed in the field for BTEX, TCE, DCA, and DCE; these compounds were detected in several wells at the site and, based on the OBG report, represent the major VOC contamination detected in the ground water. This work will be performed by Tracer Research Corporation under subcontract to Dames & Moore.

In areas suspected of containing ordnance, the procedures outlined in Section 3.1 will be followed. However, UXB will clear the location to a depth of 5 feet to allow Tracer to push the probe in a single step.

3.2.1 Drilling

Each of the shallow monitoring well borings will be advanced using 6¼-inch inside diameter hollow-stem augers to a depth of approximately 7 feet below the ground water table for shallow wells; a description of the hollow-stem auger drilling method is provided in Section 3.1.1. A rotary drill bit will be used to install the deep wells, as more fully explained in Section 3.2.4. It is anticipated that ground water will be encountered at a depth of approximately 1 foot below ground surface near the Raritan River to a depth of approximately 15 feet near the northern site boundary. A description of the hollow-stem auger drilling method is provided in Section 3.1.1. Monitoring well locations may be moved several feet, at the discretion of the field Engineer/Geologist, if boulders should impede borehole advancement.

Ambient air quality will be monitored during drilling operations using a Total Photoionization Organic Vapor Analyzer device (PID).

3.2.2 Monitoring Well Construction and Completion

The well material will consist of 2-inch PVC riser pipe and screen with threaded joints. A screen slot size of 0.010 inch is considered appropriate for this site because of the various grain sizes that may be encountered; this screen size will prevent silting while allowing proper well development. The augers will be extracted as a silica sand pack is tremied from the bottom of the borehole to approximately 2 feet above the screened section. A bentonite seal with a minimum thickness of 2 feet will be placed above the sand pack. The bentonite, either granulated, pelletized, or slurried, will be tremied in place to ensure a complete seal, and will be mixed with potable water. A 94:3 cement-bentonite grout will be placed in the annulus around the well casing from the top of the bentonite seal to the surface; no more than 11.5 gallons of water per sack of cement will be used. If a confining layer is punctured during well installation, the confining layer will be grouted to prevent the potential migration of contamination; grout characteristics are described in Section 3.1.3.

During installation, the depths of the well, sand pack and bentonite seal will be verified by taping. The quantities of materials (sand, bentonite, grout) used during installation of the well will be recorded for each well.

A protective steel collar with locking cap will be cemented in place over the PVC casing to prevent damage to the well. The wells will be seated in a concrete surface pad with approximate dimensions of 4 feet by 4 feet by 4 inches. Three 2-inch diameter steel pipes will be installed in the concrete, rising to a height approximately equal to the well, to further protect the well. Each well will be permanently labeled with its assigned number, and a N.J. state well permit tag will be permanently affixed to each monitoring well. Typical well construction is illustrated in Figure 9. Well designations are discussed in Section 5.3. Information regarding the construction of each monitoring well will be recorded on a Dames & Moore Monitoring Well Information Sheet as shown in Figure 10.

3.2.3 Shallow Monitoring Wells

All shallow monitoring wells will be constructed through the center of the hollow-stem augers.

Shallow monitoring well construction and installation will follow those procedures described in Section 3.2.2. The proposed depth of the shallow wells will be approximately 15 feet below the surface. The well generally will be installed so that the upper 3 feet of the screen extends above the ground water table into the vadose zone; installation in this manner will help to span the range of ground water fluctuation while still allowing the sampling of contaminants which might be present on the surface of the ground water. In some areas, it is anticipated the ground water will be very close to the ground surface, i.e., less than 5 feet deep; it will not be possible to install the well as described above and still have room to install a proper sand pack and seal. In these areas, the well will be installed to a depth of 15 feet; the entire screen will be within the ground water. If a relatively impervious soil layer is encountered at a shallow depth, less than 10 feet below the ground surface, the borehole may be terminated within the impervious soil layer and a 5-foot well screen may be used. The 5-foot well screen is selected to provide room for an adequate seal at the surface and prevent penetrating the confining layer during the construction of the monitoring well.

3.2.4 Deep Monitoring Wells

Deep monitoring well construction and installation will follow those procedures outlined in Section 3.2.2. Deep monitoring wells will be installed by Dames & Moore in Areas 2/3, 4, 6A/6B, 9/10, 16, and 17A. The deep well (MW-41) downgradient of Area 2/3 will be screened from 15 to 25 feet below the depth of the ground water. Well MW-44 at Area 6A/6B will be

drilled to a depth of approximately 58 feet; the screened interval for this well will be from 58 feet to 24 feet below the ground surface. Areas 4, 9/10, 16, and 17A will have cluster monitoring wells; the cluster wells will consist of one shallow and deep well pair installed within 5 feet of each other. The shallow wells will have a screened interval as shown in Section 3.2.3; the adjacent deep monitoring well generally will be screened from depths of 15 to 25 feet. If an impervious soil layer is encountered before the desired deep well depth is achieved, then the well will be installed on top of or above the soil layer; the well screen interval will change to accommodate this difference.

Double cased well design will be utilized to prevent the vertical movement of fluids from the upper part of the aquifer to the lower part of the aquifer. The double cased monitoring well construction specifications described below have been developed to allow for the monitoring of the lower portions of the aquifer with a minimum potential of cross contamination from the upper portion of the aquifer. The specifications for the double-cased well design are as follows:

- A borehole shall be advanced using 6-inch outside diameter (O.D) rotary bit to a total depth of 25- to 58 feet (location dependant).

- The outer casing will consist of clean (decontaminated) PVC or steel casing with a four-inch inside diameter. The casing will be of sufficient length to extend one-foot above grade. If the casing is greater than 20 feet in length, a centralizer will be placed near the base of the casing to center it in the auger.

- The casing will be cemented in the hole with a cement grout consisting of 5.2 gallons of potable water to each 94 lb. bag of cement with no greater than 3-percent bentonite. The cement grout will be placed by means of a tremie tube. Prior to placing the casing into the borehole, the bottom three feet of the boring will be filled with grout. The casing will then be inserted one-foot into the grout. The cement grout will be circulated from the bottom up the outside of the casing. Care will be taken to prevent voids or gaps in the grout and assure that it extends up to the original grade level. Sufficient grout will be kept on hand to handle washouts and settlement. The grout shall be allowed to cure for a minimum of 24 hours prior to further drilling operations in the borehole.

- Drill equipment and drilling tools will be steam cleaned prior to reentering the borehole. After the cement has cured sufficiently, the bottom plug will be drilled out and the casing flushed with clean potable water to allow further work to commence.

- A four-inch O.D. rotary bit will be used to drill to depth of 13 feet below the bottom of the casing. Upon completion of the lower borehole to total depth, a ten-foot length of two-inch diameter screen will be placed into the hole. The screen will be coupled to an adequate length of 2-inch diameter threaded flush-joint riser to provide a minimum of 24 inches of stick-up above grade.

- A filter sand will be placed by means of a tremie pipe in one continuous operation from the bottom of the screen to a maximum of two feet above the top of the screen. The annular area immediately above the filter will be sealed with bentonite to a minimum thickness of two feet and extending a minimum of one-foot into the outer casing. The annular space above the bentonite seal will be filled with a cement grout. The grout (consisting of cement with no greater than 3 percent bentonite) will be placed from the bottom up to the ground surface using a tremie tube.

- A protective steel casing with locking cap will be placed around each well. A 4' x 4' x 4" concrete pad will be placed around the surface casing to facilitate drainage away from the well and to prevent the ponding of water around the well head; three 2"-diameter steel posts will be installed through the concrete pad to protect the well. Each well will be permanently labled with its assigned number, and a New Jersey state well permit tag will be permanently affixed to each monitoring well.

During the construction of the deeper wells, the Dames & Moore field engineer will record the amount of potable water lost during the drilling. During well development, a minimum of three times the amount of water lost, or three times the well volume, which ever is greater, will be removed.

3.2.5 Well Development and Water Sampling for Off-Site Analysis

All wells will be developed at least 48 hours after completion to insure that relatively sediment-free water samples can be obtained. All wells will be developed by pumping and mechanical surging until relatively sediment-free water can be obtained. A minimum of three well volumes will be removed. Foreign sources of water will not be involved during the well development process.

Ground water samples will be obtained from the monitoring wells, after proper well development, using an ISCO non-dedicated sampling system. Prior to sample collection, a stabilization test will be performed on each well to help ensure that standing water in the well casing has been removed and that the sample will be representative of the aquifer. To perform the stabilization test, the well will be bailed or pumped while monitoring the pH, temperature, and specific conductance of the discharge by using a pH meter, thermometer, and conductivity meter, respectively. When three successive readings (taken at intervals of one well volume) of each parameter give equivalent values, the well is considered to have stabilized. The final measurements are considered equivalent if they fall within the following ranges:

Specific conductance (temperature corrected): ± 10 umhos/cm
pH: ± 0.1 pH unit
Temperature: ± 0.5°C.

An example of the form to be filled out during the stabilization test is shown in Figure 11.

Water samples will be pumped directly to the laboratory-supplied sample containers; turbulence will be minimized during the transfer to prevent the loss of volatile organics. Containers for VOC samples will be filled to capacity to help minimize the loss of volatile constituents to the head space.

Water removed from all new monitoring wells during development and stabilization will be disposed in accordance with procedures stated in Section 13.0. If the water is placed into drums, the drums will be labeled properly with information concerning drum contents, applicable dates, and the origin of contents.

Water samples will be stored on ice from their time of acquisition until delivered to the laboratory. Sample containers will be stored in protective coolers and will be adequately padded to help prevent breakage, as described in Section 10.0.

All monitoring well protective casings will be locked immediately following the sampling procedure to help prevent the introduction of foreign materials into the well. The wells will be left in place at the site in the event additional samples are required, and to provide a means of checking ground water depth.

3.2.6 Ground Water Level Measurement

The depth to ground water will be measured in each well from the top of the PVC casing. This measurement will be made to the closest 0.01 foot using an electronic water level indicator. The distance from the top of the PVC casing to the ground surface will be recorded to the nearest 0.01 foot.

Water levels in each well will be measured once each day on 3 consecutive days. These triplicate measurements will be useful for confirming that the wells have stabilized, and may provide an indication of the magnitude of short-term ground water fluctuations. It is anticipated that these measurements will be performed after all ground water sampling activities have been completed. Obtaining ground water level measurements after all wells have been installed helps to eliminate errors in determining the ground water gradient by decreasing the effects of gradual changes in the ground water level over extended periods of time.

3.3 SAMPLING OF EXISTING WELLS

Ground water samples will be collected from existing OBG-installed monitoring wells identified and described in Section 4.0. The procedures for stabilizing and sampling described in Section 3.2.4, and measuring the depth to ground water described in Section 3.2.5, will be followed for sampling these existing wells.

3.4 SURFACE WATER AND SEDIMENT SAMPLING

Surface water sample locations were noted during the Dames & Moore site reconnaissance. Surface water and sediment samples will be collected for chemical analyses from Areas 3, 4, 5, 6A, 8, and 11. The number of samples to be obtained from each area is described below:

Area	No. of Surface Water and Sediment Samples
3	1
4	2
5	1
6A	3
8	1
11	1

The proposed chemical analyses are described in Section 4.0.

The surface water samples will be obtained by submerging the sample container into the water where the suspect contamination was noted. However, sample containers that contain preservatives will be filled by filling a dedicated laboratory-cleaned sample jar and then transferring its contents into the appropriate container. If the location of the sample does not appear to contain water that is deep enough to completely submerge a complete sample jar, the water will be collected following the same procedures described for filling the jars which contain preservatives. Surface water will be collected until either the analytical parameter jars are full or the water matrix becomes depleted enough that sediment and other debris begins to "contaminate" the sample. Sample preparation, handling, and packaging procedures are described in Section 10.0.

Sediment samples will be obtained by a stainless steel trowel from areas with visible contamination (if present), or in the same location used to obtain surface water samples.

3.5 SURFACE SOIL SAMPLING

One surface soil sample will be obtained in Area 11 of the former arsenal site. Visual reconnaissance will be performed in selected sections of Areas 12 and 16; if evidence of surficial soils contamination is found, surficial soil samples will be taken after discussion with the USACE.

Surficial soil samples will be taken from 0- to 6 inches below the ground surface. Sampling will be achieved by using a stainless steel trowel and a flat stainless steel knife. The proper sample containers will be provided by the laboratory. The soil sample will be representative of the surficial soils suspected of being contaminated; any debris that is not considered representative of the surficial soils will be discarded.

Decontamination procedures for all tools utilized during the sampling are described in Section 7.0; all sampling devices used will be decontaminated prior to each sampling event.

3.6 SOIL GAS SURVEY

The soil gas survey will be conducted by Tracer Research Corporation under subcontract to Dames & Moore. Approximately 300 locations (one point per location) will be assessed to detect VOC concentrations in the soil gases. This survey will be used to select the placement of monitoring wells throughout the site; it will be particularly useful in areas known to contain VOC contamination, such as Areas 1, 2, 3 and 9.

Additionally, the soil gas survey will be used to select soil sampling locations. In some areas, such as Areas 7 and 17A, the soil gas survey will be based on a grid system; in other areas, such as Areas 2 and 3, the soil gas survey will be based on site conditions such as distressed vegetation, unusual surface features, staining, or other visible signs of potential contamination.

The soil gas samples will be collected from depths of 2 to 5 feet below ground surface. Tracer Research does not recommend obtaining soil gas samples at depths of less than 2 feet; therefore, no soil gas survey will be conducted in portions of the site where the ground water is less than 2 feet below ground surface. In no event will the soil survey be conducted at depths greater than 5 feet.

Prior to conducting the soil gas survey, an unexploded ordnance investigation will be conducted by UXB, Inc. The procedure followed generally will be as stated in Section 3.1. However, UXB will clear the sample location to a depth of 5 feet to allow Tracer Research to push the probe to the required sampling depth in a single step.

The soil gas survey will be conducted in the following manner:

- A truck or van-mounted hydraulic unit will be used to push a 3/4-inch diameter galvanized pipe to the desired sampling depth.

- A vacuum pump then will be used to purge 2 to 5 liters of soil gas from the collection system.

- A gas sample then will be obtained and analyzed in a gas chromatograph located in the truck/van.

- Verbal results will be available within a short time frame, allowing the field program to be modified, as necessary.

- A printed, draft copy of the analytical results will be available at the end of each day.

- Hard copies of the analytical results will be sent to the Tracer Research office for QA/QC review. A written report, including QA/QC and analytical results, then will be prepared at the conclusion of the soil gas survey.

- Standardization of the GC will be conducted each morning by injecting known concentrations of the selected contaminants into the GC three times and checking the response factor. Additional QA checks will be performed daily.

- For this project, the soil gas samples will be analyzed in the field for benzene, toluene, ethylbenzene and total xylenes (BTEX), trichloroethene (TCE), 1,1-dichloroethene (DCE), and 1,1-dichloroethane (DCA).

A detailed description of the soil gas survey procedures is presented in Appendix B.

4.0 AREAS OF POTENTIAL CONTAMINATION

4.1 AREA 1

Area 1 is part of a section of the Raritan Arsenal that is currently occupied by the United States Environmental Protection Agency (USEPA). The USEPA is currently assessing the presence of contamination in their area, including Area 1; the results of the EPA study were not available at the time this work plan was developed. With the exception of obtaining ground water samples from the existing OBG monitoring wells, Dames & Moore will not perform any field investigations in Area 1 under the current scope of work; this area will be addressed in a later phase of the project.

The following discussion is presented only to provide a more-complete summary of the OBG investigation of the Raritan Arsenal.

4.1.1 Background and Previous Site Studies

OBG reported that Area 1 is approximately 0.6 acre in size, and was used as a demolition ground after WWI and into the early 1930s. Ordnance destroyed at this site included adapter boosters, point and base detonating fuses, and 37-mm to 6-inch gun projectiles of various explosive fills.

Area 1 was surface cleaned by LEAD in the 1963 decontamination effort; it subsequently was recommended for "Surface Use Only." The potential hazards identified in Area 1 include surficial and subsurface unexploded ordnance as well as potential contamination from volatile organics and heavy metals.

The 1987 and 1988 OBG Contamination Evaluation listed Area 1 as a medium priority site. Access constraints restricted drilling to the area north of the stream. The elements of OBG's field investigation and a summary of their findings are presented below:

OBG - AREA 1	
INVESTIGATION	**RESULTS**
2 UXO Searches	None found
Geophysical Surveys - Magnetometer - GPR	No indication of buried objects
4 Surficial Soil (SS1-1, SS1-2, SS1-3, SS1-4)	VOCs - Not detected (ND) Lead (128 ppm) Explosives - ND
3 Soil Borings (B-4, B-5, and B-6) Samples collected from depths of 0-5', 5-10', and 10-15'	VOCs - below NJ Action Levels Metals - below NJ Action Levels Explosives - ND
Ground Water 3 Shallow Monitoring Wells (MW-7, MW-8, MW-9)	VOCs - 8 ppb T-1,2-DCE - 170 ppb TCE
1 Deep Monitoring Well (MW-31)	VOCs - 17 ppb T-1,2-DCE - 250 ppb TCE Total metals below MCLs TRPH - ND Explosives - ND

4.1.2 Area 1 Field Effort Summary

The following table presents a summary of Dames & Moore's field investigation activities, analytical parameters, and justification for performing them.

DAMES & MOORE - AREA 1		
ACTIVITY	**PARAMETERS**	**REASON**
Ground Water Sampling of OBG monitoring wells - 4 existing wells	VOCs, Semivolatiles, Metals, Explosives, Pesticides	VOCs were detected in ground water samples collected by OBG. This activity will determine if VOC contamination is still present in ground water samples, and assess the presence of other contaminants not considered during OBG's assessment.

4.2 AREA 2

4.2.1 Background and Previous Studies

OBG reported that Area 2 is approximately 14 acres in size and was used as a demolition ground between 1917 and the early 1930s. Ordnance destroyed at this site included adapter boosters, point and base detonating fuses, and 37-mm to 6-inch gun projectiles of various explosive fills.

Area 2 was cleaned by LEAD during the 1963 decontamination effort; it subsequently was recommended for "Surface Use Only." Potential hazards in this area include unexploded ordnance below the surface, and soil and ground water contamination from ordnance residues and heavy metals.

Area 2 is partially developed; the undeveloped portion is part of an area studied by the New Jersey State Hazardous Waste Facilities Siting Commission as a potential location for a

hazardous waste incinerator. The Commission installed three monitoring well nests and two pairs of piezometers throughout the study area; some of these wells may be in Area 2. Details of the well installation and the analytical results are unknown.

OBG performed a contamination evaluation in 1987-1988; Area 2 was listed as a medium priority site. The elements of OBG's field investigation and a summary of their findings are presented below:

OBG - AREA 2	
INVESTIGATION	**RESULTS**
2 UXO Searches - spot checks - along geophysical survey lines	None found
Geophysical Surveys - Magnetometer - GPR	Evidence of subsurface anomalies, 3-9 feet deep
7 Surficial Soil Samples: (SS2-1 through SS2-7)	VOCs detected below action levels - potential contamination Metals detected below action levels Explosives - ND
2 Soil Borings (B-10, B-11) Samples from: 0-5', 5-10', 10-15'	- VOCs detected below action levels - potential contamination - Metals (Mercury 25.8 ppm) - Explosives - ND
3 Ground Water Samples from Shallow Monitoring Wells: MW-13 through MW-15	- VOCs detected: (T-1, 2-DCE - 18 ppb, TCE - 43 ppb) - Metals detected below MCLs - TRPH - (6 ppm) - Explosives - ND

4.2.2 Site Reconnaissance and Observation

This area now is partially developed with buildings and roadways; the undeveloped portion is north of Raritan Center Parkway and consists of uneven ground with trees and brush. No areas of surface water were observed during the site reconnaissance. OBG-installed

monitoring wells MW-13 and MW-15 were located. Five unlabeled monitoring wells, 2 labeled wells (SP-1, SP-2), and 2 piezometers also were located; these wells may be part of the investigation performed by the New Jersey Hazardous Waste Facilities Siting Commission.

4.2.3 Dames & Moore Initial Studies

The undeveloped portion of Area 3 north and west of Raritan Center Parkway, will be investigated along with Area 2 because they are contiguous and have virtually indistinguishable features.

4.2.3.1 Soil Borings

To assess the extent of metal and VOC contamination in the soils of the undeveloped portions of Areas 2/3 (north of Raritan Center Parkway), a total of 40 soil borings will be advanced. These borings will be located by a combination of techniques, as follows:

- A limited soil gas survey. Up to 30 potential sampling locations will be assessed by Tracer Research, Inc.

- Visual observations. Up to 20 boreholes will be advanced adjacent to unusual surface features such as mounds of soil which appear to be man-made because of their shape, or in areas with characteristics that vary from surrounding land features, areas which have distressed or no vegetation, and similar factors.

- A grid sampling system. Areas where visual inspection and soil gas sampling do not detect irregularities will be assessed by constructing a grid. The grid interval will be determined after the soil gas survey and visual inspection have been performed, but is anticipated to be in the range of 100 to 150 feet. The results of the soil gas survey will also play a part in locating these boreholes. It is anticipated that up to six of the boreholes will be placed within 15 feet of OBG borings B-10 and B-11, if they can be located, to assess the mercury contamination found by OBG.

Soil borings will be placed at each grid node; samples will be collected from depths of 0 to 12", 2 to 3', and 4 to 5' and will be analyzed for VOCs, metals, and explosives.

Soil samples will be submitted for chemical analysis for metals from the upper and lower sampling intervals to help determine the extent of metal contamination (primarily mercury) in the shallow soils.

Explosives were not detected in any soil samples analyzed during the OBG investigation. However, because the area was used for explosive demolition, soil samples will be obtained from the upper and middle sampling intervals for analysis of explosives.

Low concentrations of VOCs, below New Jersey action levels, were detected in soil samples from Area 2. To assess the extent of contamination, one soil sample from the lower sampling interval of each borehole will be analyzed.

No soil borings are proposed in the developed portions of this area. The soils in these areas have been disturbed and/or removed and are not representative of conditions which existed prior to development.

4.2.3.2 Monitoring Well Installation and Ground Water Sampling

To further evaluate the quality of the ground water up- and downgradient of Areas 2 and 3, two monitoring wells will be installed and sampled (see Figure 2). A shallow upgradient well (MW-40) will be installed near the railroad tracks north of Areas 2 and 3. A deep downgradient well (MW-41) will be installed south of Areas 2 and 3; VOCs were detected in shallow wells in this area. The location of the wells will be based, in part, on access and a soil gas survey of up to five potential well locations for each well installed.

Ground water will be sampled from the two new wells, from existing upgradient well MW-13, and from existing wells MW-11, MW-12, and MW-15 which are downgradient from Areas 2 and 3. Ground water samples will be analyzed for VOCs, semivolatiles, explosives, pesticides, and metals.

Well permitting, installation, construction, development, and sampling protocols are described in the appropriate subsections of Section 3.0.

4.2.4 Area 2 Field Effort Summary

The following table presents a summary of Dames & Moore's field investigation activities, analytical parameters, and justification for performing them.

DAMES & MOORE - AREA 2		
ACTIVITY	**PARAMETER**	**REASON**
UXO Survey	Subsurface Ordnance	A UXO search will be conducted to clear the area prior to any invasive activities. If anomalies are detected, no drilling will be performed in the suspect area.
Soil Borings/Sampling Approximately 40 borings Sampling depths: 0-12", 2-3', 4-5' Locations will be based on the soil gas survey, physical irregularities (up to 20 boreholes) and a grid system (up to 20 boreholes)	VOCs, Metals, Explosives	Metals and VOCs were detected in soil samples collected by OBG. This activity will help determine the horizontal and vertical extent of the contamination.
Soil Gas Survey	VOCs	A soil gas survey will be conducted in an effort to define VOC contamination in the soils, and to locate the monitoring wells.
Monitoring Well Installation and Ground Water Sampling - 1 new upgradient well (shallow) - 1 new downgradient well (deep) - Sample new and four existing wells - 1 upgradient existing well - 3 downgradient existing wells	VOCs, Semivolatiles, Metals, Explosives, Pesticides	To confirm and help determine extent of VOC contamination identified by OBG in MW-13, and to assess general ground water quality impact from Areas 2 and 3.

Boring locations will be based on the soil gas survey, physical irregularities (up to 20 boreholes), and a grid system (up to 20 boreholes).

4.3 AREA 3

4.3.1 Background and Previous Studies

OBG reported that Area 3 was a demolition and burning ground until 1948. Components destroyed at the site included adapter boosters, point and base detonating fuses, and projectiles of various explosive fills for 37-mm to 6-inch guns. Ground pits and aboveground chambers were used to destroy fuses, primer detonators, small arms, artillery primers, and pyrotechnics. OBG reported that some areas on the site were used for surface burning of smokeless powder and salvaged low and high explosives. OBG further reported that Area 3 consists of 22 acres, that two small parcels together amounting to 1.9 acres were fenced, and that Area 3 had been filled with several feet of soil prior to 1963.

These demolition areas comprising Area 3 were designated as to their future use during the 1963 decontamination effort by LEAD; the fenced areas were recommended "Non-Use," and the remainder of Area 3 was recommended for "Surface Use Only."

Part of the undeveloped section of Area 3 was studied along with part of Area 2 by the State of New Jersey as a potential site for a hazardous waste incinerator, as stated in Section 2.2.1.

OBG conducted a contamination evaluation in 1987-1988 and listed Area 3 as containing both high and medium priority sites. The elements of OBG's field investigation and a summary of their findings are presented below:

OBG - AREA 3	
INVESTIGATION	**RESULTS**
UXO Search & Removal	Igniters, fuses, and small projectiles removed
Geophysical Surveys - Magnetometer - GPR	Evidence of subsurface anomalies

INVESTIGATION	RESULTS
7 Surficial/Soil Samples: (SS3-1 through SS3-7)	- VOCs detected below action levels - Metals detected: (Lead 235 ppm - SS3-3) - Explosives: (2,4,6-TNT 7.28 ppm)
8 Soil Borings/Sampling: (B-12 through B-18) 3 Samples from each boring: 0-5', 5-10', 10-15'	- VOCs detected below action levels - Metals detected (Lead 188 ppm) - Explosives - ND
3 Monitoring Wells/Ground Water Samples MW-13 through MW-15 (also described in Area 2)	VOCs detected: (Trans-1,2-DCE-18 ppb; TCE-43 ppb) - Metals detected below MCLs - TRPH - (6 ppm) - Explosives - ND

4.3.2 Site Reconnaissance and Observation

During the site reconnaissance, Dames & Moore discovered one "fenced" area within the undeveloped section of Area 3, north of Raritan Center Parkway. This "fenced" area was readily accessible; the fence consisted of short (approximately 3 to 4 feet high) wooden posts which supported a wide mesh, thin diameter metal fence material. Most of the fence was missing. The area within the fence was noticeably lacking in vegetation. Within the undeveloped portion of Area 3, Dames & Moore also observed small hills and mounds of disturbed soil. A small, undeveloped, and largely undisturbed section of Area 3 is located east of Raritan Center Parkway and north of Clover Place; there is a small stream or ditch in this section. The remainder of Area 3 south of Raritan Center Parkway is fully developed, paved, and/or landscaped.

4.3.3 Dames & Moore Initial Studies

4.3.3.1 Soil Borings/Sampling

The portion of Area 3 that is contiguous to Area 2, north of Raritan Center Parkway, has been discussed in Section 2.2.3.2. A grid will be established in the undeveloped section of Area 3 that is east of Raritan Center Parkway to assess the extent of contamination in the shallow soils. The grid lines will be at 100-foot intervals, and boreholes will be advanced at each grid node. Soil samples will be collected at depths of 0- to 12 inches, 2- to 3 feet, and 4- to 5 feet, and will be analyzed for VOCs, metals, and explosives.

In the grassy strip of ground where MW-15 is located, approximately 4 soil borings will be advanced at 100-foot intervals. Soil samples will be collected at 0- to 12 inches, 2- to 3 feet, and 4- to 5 feet to assess the presence of soil contamination in this part of Area 3. These samples will be analyzed for VOCs, metals, and explosives.

The above soil samples will be submitted for chemical analysis for metals from the upper and lower sampling intervals to help determine the extent of metal contamination (primarily lead) in the shallow soils.

Explosives were detected in one shallow soil sample analyzed during the OBG investigation. For this reason, and because the area was used for explosive demolition, soil samples will be obtained from the upper and middle sampling intervals for analysis of explosives.

Low concentrations of VOCs, below New Jersey action levels, were detected by OBG in soil samples from Area 3. To assess the extent of contamination, one soil sample from the lower sampling interval of each borehole will be analyzed.

An approximately 1/8-acre partially fenced parcel is located in the undeveloped section of Area 3 (north of Raritan Center Parkway). A grid will be established over this area with 40-foot intervals; soil borings will be advanced at each grid node and samples will be collected from three intervals at depths of 0- to 12 inches, 2- to 3 feet, and 4- to 5 feet. Soil samples will be submitted for chemical analysis for metals from the upper and lower sampling intervals to help determine the extent of metal contamination (primarily lead) in the shallow soils. Explosives

were not detected in composite soil samples obtained from soil borings in this area during the OBG investigation; however, because the area was reportedly used for explosive demolition, soil samples will be obtained from the upper and middle sampling intervals for analysis of explosives.

4.3.3 Surface Water and Sediment Sampling

One surface water and one sediment sample will be collected from the small stream described in Section 4.3.2, and will be submitted for chemical analyses for metals, explosives, VOCs, semivolatiles, and pesticides.

4.3.4 Area 3 Field Effort Summary

The following table presents a summary of Dames & Moore's field investigation activities, analytical parameters, and justification for performing them.

DAMES & MOORE - AREA 3		
ACTIVITY	**PARAMETER**	**REASON**
UXO Survey	Subsurface Ordnance	A UXO search will be conducted to clear the area prior to any invasive activities. If anomalies are detected, no drilling will be performed in the suspect area.
Soil Boring/Sampling - grid (100-foot interval); east of Raritan Center Parkway; approximately 12 borings Sampling depths: 0-12", 2-3', 4-5'	VOCs, Metals, Explosives	Metal and explosive contamination was detected in OBG soil samples from this area. This activity will help determine the horizontal and vertical extent of the soil contamination.

DAMES & MOORE - AREA 3		
ACTIVITY	**PARAMETER**	**REASON**
- Grid (40-foot interval); Fenced area; approximately 10 borings Sampling depths; 0-12", 2-3', 4-5'	Metals Explosives	Metals and explosives were detected in OBG soil samples from this area. This activity will help determine the horizontal and vertical extent of this potential contamination.
- Centered at 100-foot intervals along grass strip by MW-15; approximately 4 borings Sampling depths: 0-12", 2-3', 4-5'	VOCs, Metals, Explosives	This activity will help assess potential contamination in this part of Area 3. This strip of property has not been extensively developed.
Surface Water and Sediment Sampling - Area 3, south of Raritan Center Pkwy, and northeast of Clover Place - 1 each, surface water and sediment	Metals Explosives VOCs Semivolatiles Pesticides	To help assess general quality of surface water and sediments at this location.

4.4 AREA 4

4.4.1 Background and Previous Studies

OBG reported in its Contamination Evaluation-Final Report that Area 4 was a high explosive salvage and melt-out area used by Columbia and Delaware Salvage Company. They reportedly conducted demilitarization of various caliber and types of complete rounds, and of separate loaded ammunition from 75-mm to 12-inch, from WWI up to the early 1920s.

In 1963, LEAD performed only a visual inspection of the area; no decontamination was performed. LEAD recommended that 7.09 acres of the total 25 acres be fenced and classified as "Non-Use." No recommendations of any kind were made for the remainder of the 25 acres;

these areas have been almost completely developed by Federal Business Centers; most of the undeveloped portion is heavily wooded.

OBG conducted a contamination evaluation in 1987-1989 and listed the fenced, non-use portion of Area 4 as a high priority site, and the unclassified portion as a low priority site. The potential hazards for this area were reported to include surficial and subsurface unexploded ordnance and explosives, contamination of the soil and ground water from exploded and unexploded ordnance, and heavy metals.

The elements of OBG's field investigation and a summary of their findings are presented below:

OBG - AREA 4	
INVESTIGATION	**RESULTS**
UXO Survey & Removal - spot checks - along geophysical survey lines	Scattered bulk high explosives, ordnance fragments, and one 9-inch diameter projectile
Geophysical surveys - Magnetometer - GPR	No indication of buried objects in surveyed areas
Surficial Soil - 8 shallow soil samples: (SS4-1 through SS4-8)	- VOCs - ND - Metals (Lead - 3,150 ppm) - Explosives (2,4,6-TNT-120,000 ppm)
4 Soil Borings: (B-19 through B-22) - from 3 intervals of 0-5', 5-10', 10-15'	- VOCs - ND - Metals detected (lead 303 ppm) - Explosives: 2,4,6-TNT-76.4 ppm

OBG - AREA 4	
INVESTIGATION	**RESULTS**
Monitoring Well Installation and Ground Water Sampling - 3 monitoring wells: (MW-13 through MW-15)	- VOCs - ND - Metals detected below MCLs-potential contamination - TRPH - ND Explosives (HMX 1.43 ppb, RDX 2.09 ppb, 1,3,5-TNB 3.93 ppb)

4.4.2 Site Reconnaissance and Observation

Dames & Moore field representatives found but did not enter the fenced area within Area 4, and located OBG monitoring wells MW-17, MW-18, and MW-19. Unfenced portions of Area 4 south of Clover Place are partly developed and partly wooded; a marshy area with standing water is located further south. There is also a salvage operation/construction debris dumping area southeast of MW-17 and south of the marshy area.

An area of shallow standing water was found west of the fenced area across a set of railroad tracks. A visible sheen was present on top of the water in some areas; it is not known if this sheen is the result of natural or man-made causes.

4.4.3 Dames & Moore Initial Studies

4.4.3.1 Soil Sampling

The fenced area is presently being cleared by an Army unit from Huntsville, Alabama. No soil sampling will occur within the fenced area or along its narrow perimeter until the area has been cleared by the Army.

After the Army has completed its activities, six borehole locations will be established along the perimeter of the fenced area, at approximately 150-foot intervals. Five additional boreholes will be located within the fenced area to provide coverage of those areas not adjacent

to the fence; areas of apparent contamination will be given preference during the sampling effort. Samples will be collected from depths of 0- to 12 inches, 2- to 3 feet, and 4- to 5 feet.

A grid will be established on the southeast side of Clover Place and southeast of a small stream to assess the areas not surrounded by the fence. The gridded area will cover a wooded area adjacent to the stream and the parking lot adjacent to the wooded area. The grid interval will be 100 feet and borings will be placed at each node; samples will be collected from depths of 0- to 12 inches, 2- to 3 feet, and 4- to 5 feet. These samples will be analyzed for VOCs, metals, and explosives.

The soil samples described above will be submitted for chemical analysis for metals from the upper and lower sampling intervals to help determine the extent of metal contamination (primarily lead) in the shallow soils.

Explosives were detected in soil samples analyzed during the OBG investigation. For this reason, and because the area was used for explosive demolition, soil samples will be obtained from the upper and middle sampling intervals for analysis of explosives.

Low concentrations of VOCs, below New Jersey action levels, were detected in soil samples from Area 4. To assess the extent of contamination, one soil sample from the lower sampling interval of each borehole will be analyzed for VOCs.

Soil sample locations will be biased toward drain lines or ditches which drain the fenced area, if these features exist.

4.4.3.2 Monitoring Wells and Ground Water Sampling

Three OBG-installed monitoring wells, MW-17, MW-18, and MW-19 were found in the field; well MW-18 is reported to be upgradient, while MW-17 and MW-19 reportedly are downgradient, of Area 4. Three additional monitoring wells (one well cluster - MW-42A & B; MW42-B; one shallow - MW-43) will be installed at downgradient locations to help determine the extent of ground water contamination (primarily explosives). Additionally, the ground water sample collected from the monitoring well installed downgradient of Area 3 will provide further indication of ground water quality downgradient of Area 4 because these areas are contiguous.

The location of the wells will be placed, in part, on access and a soil gas survey of up to five potential well locations for each well installed.

The new downgradient wells will be placed adjacent to the construction debris dumping area south of MW-17 (see Figure 2). Ground water samples will be collected from the three new wells and from three existing wells; these water samples will be submitted for chemical analysis for VOCs, semivolatiles, pesticides, metals, and explosives.

The monitoring wells will be permitted, installed, developed, and sampled as described in the appropriate subsections of Section 3.0.

4.4.3.3 Surface Water and Sediment Sampling

Surface water and sediment samples will be collected from the two locations described in Section 2.4.2. These samples will be analyzed for VOCs, semivolatiles, metals, and explosives. The wooded/marshy area precludes access by a drill rig immediately downgradient of Area 4; a surface water sample and sediment sample from this area will provide an indication of contamination in this area.

4.4.4 Area 4 Field Effort Summary

The following table presents a summary of Dames & Moore's field investigation activities, analytical parameters, and justification for performing them.

DAMES & MOORE - AREA 4		
ACTIVITY	PARAMETER	REASON
Soil Boring/Sampling - grid (100-foot interval) Area southwest of Clover Place Approximately 6 borings Sampling depths: 0-12", 2-3', 4-5' 11 boreholes in fenced area at same depths (six along the fence, five in areas of apparent contamination)	VOCs, Metals, Explosives	VOCs, metals, and explosives were detected in the soil samples collected by OBG. This activity will help determine the horizontal and vertical extent of the contamination
Monitoring Well Installation/ Ground Water Sampling - 1 new shallow downgradient well - 1 new well cluster - 3 existing wells: (MW-17 through MW-19)	VOCs, Semivolatiles, Metals, Explosives, Pesticides	Metals and explosives were detected in ground water samples collected by OBG. This activity will help determine the extent of ground water contamination associated with Area 4.
Surface Water and Sediment Sampling - 1 each near railroad tracks and fenced area - 1 each in marshy area south-southwest of fenced area	VOCs, Semivolatiles, Metals, Explosives, Pesticides	A sheen was observed on the surface of standing water near the fenced area; this activity will help assess the surface water quality at this location. Access is limited in the area south-southeast of Area 4; sampling of the marshy area will provide an indication of contaminant migration caused by surface water runoff from Area 4.

4.5 AREA 5

This area is currently scheduled for cleaning by an Army unit from Huntsville, Alabama. Therefore, other than sampling the existing wells and obtaining surface water and sediment samples, Dames & Moore will not perform any field investigations in Area 5 under the current scope of work; this area will be addressed in a later phase of the project.

4.5.1 Background and Previous Studies

OBG reported that Area 5 was used as a chemical burial ground after WWI and into the early 1960s, and that the U.S. Army Chemical Corps used this area for the disposal of mustard gas, potassium cyanide, fuming red nitric acid, and other chemicals from the arsenal. All disposals reportedly were performed in trenches to a depth of 5 feet. OBG further reported that soil samples were collected from five areas to a depth of 4.5 feet in 1961. These soil samples were tested with a chemical agent detector kit (M-18) for the presence of mustard gas; the results were positive. Several munition casings were recovered at this time as well.

LEAD did not perform decontamination at this site in 1963, but erected a fence and recommended it as a "Non-Use" area. The potential hazards identified at this site include mustard agent, potassium cyanide, and red fuming nitric acid. Contamination of the soil and ground water could have occurred due to the method of disposal of these chemicals.

In 1971, representatives of Edgewood Arsenal conducted testing of soil samples to a depth of 3 feet using the M-18 detector kit. These results were inconclusive.

OBG conducted a contamination evaluation and listed Area 5 as a high priority site. The elements of OBG's field investigation and a summary of their findings are presented below:

OBG - AREA 5	
INVESTIGATION	**RESULTS**
UXO Survey & Removal 3 surveys - initial - geophysical survey lines - MW installation areas	A mustard or acid gas emission unit was removed 3 large objects identified

OBG - AREA 5	
INVESTIGATION	**RESULTS**
Geophysical Survey - Magnetometer - GPR	Evidence of subsurface anomalies
Soil Sampling Surficial samples collected during drilling of MW-20	Field screening only, possible detection of cyanide No deep soil samples
Monitoring Well Installation and Ground Water Sampling 3 Monitoring Wells: (MW-20 through MW-22)	- VOCs - ND - Metals detected below MCLs - TRPH - ND - Explosives - analysis not performed

4.5.2 Site Reconnaissance & Observation

The fenced area is in a segment of the former Arsenal site that is undeveloped and covered with dense brush to the north, northeast, and northwest, and marsh grass to the south and southwest. Along the southern edge of the fenceline and in the southwest corner of the fenced area were standing water and tall marsh grasses. The fence appeared intact except for one section that was down and permitted easy access to the area. The remains of "Police Line - DO NOT CROSS" tape were observed near the gate and the adjacent road. Monitoring wells MW-20, MW-21, and MW-22 were located. The remains of sporadic, household effects dumping were observed along the gravel road east of Area 5.

4.5.3 Ground Water Sampling

Ground water samples will be collected from the three existing monitoring wells: MW-20, MW-21, and MW-22. These water samples will be submitted for chemical analysis of VOCs, semivolatiles, cyanide, metals, pesticides, explosives, dithiane, oxathiane, and thiodiglycol.

4.5.4 Surface Water and Sediment Sampling

Surface water sample and sediment samples will be collected downgradient of the fenced area between MW-20 and MW-21; this is the area of standing water described in Section 2.5.2. These samples will be submitted for chemical analyses for VOCs, semivolatiles, pesticides, cyanide, metals, explosives, dithiane, oxathiane, and thiodiglycol.

4.5.5 Area 5 Field Effort Summary

The following table presents a summary of Dames & Moore's field investigation activities, analytical parameters, and justification for performing them.

DAMES & MOORE - AREA 5		
ACTIVITY	**PARAMETER**	**REASON**
Ground Water Sampling Existing shallow monitoring wells: MW-20 MW-21 MW-22	VOCs Semivolatiles Metals Cyanide Dithiane Oxathiane Thiodiglycol Pesticides	No VOCs, hydrocarbons, or metals above MCLs were identified. This activity will further assess the ground water quality for additional parameters.
Surface Water and Sediment Sampling - between MW-20 and MW-21	Cyanide Metals Explosives Dithiane Oxathiane Thiodiglycol Pesticides VOCs Semivolatiles	This activity will help assess the surface water quality and the presence of contamination in the sediments immediately adjacent to the fenced area.

4.6 AREA 6

4.6.1 Background and Site Previous Studies

OBG reported that Area 6 is composed of two distinct sections. These sections were used as burning grounds to destroy various ammunition components up to and including the Arsenal close-out period in 1963. OBG further reported that this area encompasses 6 acres.

In approximately 1966, LaPlace, Inc., placed a sulfuric acid production unit at the southeastern corner of the western segment in Area 6. This plant operated until it was shut down by the NJDEP in 1984. Reportedly, landowners claimed that numerous spills have occurred from this production unit. Other than LaPlace, Inc., Area 6 and the surrounding property are generally undeveloped marsh lands, with some built-up areas used for roadways, railroads, or levees.

The soil in the area was disked to a depth of 6 inches and surface-cleaned of ammunition and components on three separate occasions, was surface-cleaned with rakes by LEAD in the 1963 decontamination effort, and subsequently was recommended for "Unrestricted Use." The potential hazards identified in Area 6 include contamination of the soil and ground water from explosion residues, heavy metals, and by-products from LaPlace, Inc.

The 1987 and 1988 OBG Contamination Evaluation listed the segment of Area 6 upon which the LaPlace, Inc., plant is located as a medium priority site, and the other segment as a low priority site. The elements of OBG's field investigation and a summary of their findings are presented below:

OBG - AREA 6	
INVESTIGATION	**RESULTS**
UXO Search	None found
3 Surficial Soil Samples (SS6-1, SS6-2, SS6-3)	VOCs - ND Metals - below NJ Action Levels Explosives - ND
3 Soil Borings (B-28, B-29, B-30) Samples from 3 depth intervals: 0-5 feet, 5-10 feet and 10-15 feet	VOCs - ND Metals - below NJ Action Levels Explosives - ND (analyzed in 0-5 feet composite only)
Ground Water 3 shallow wells: (MW-25, MW-26, MW-27) 2 deep wells: (MW-16, MW-34)	VOCs - ND Total Metals below MCLs Explosives - 1.54 ppb Tetryl (MW-16) TRPH - ND

4.6.2 Site Reconnaissance and Observation

Signs of contamination are evident in the vicinity of the LaPlace, Inc. acid plant, including areas with spilled by-product, standing water with visible surface sheen, distressed vegetation, stained soil, and abandoned drums. The former plant manager, Mr. John Manell, stated that the spilled by-product was an inert material, that the only chemical used for water treatment was phosphate, and that the product was shipped off site. The segment of Area 6 in the vicinity of this plant will be referred to hereafter as Area 6A.

The eastern segment of Area 6, hereafter referred to as Area 6B, is undeveloped and lies between Black Ditch and a north/south dirt patrol road. The area is overgrown with tall marsh grasses and contains low mounds of soil. Portions of the soil were found to have an odor resembling burnt firecrackers, and a consistency of peat. This area has approximate dimensions of 20 feet by 200 feet.

An additional area, north of Area 6B, was also found to have mounds of soil. Portions of the soil in these mounds had a similar odor and characteristics as the soils in Area 6B. These soil mounds are scattered in an area several hundred yards long (along the east side of Black Ditch) by 50 to 100 feet wide. This area has been designated 6B-north.

4.6.3 Dames & Moore Initial Studies - Area 6A

4.6.3.1 Soil Borings/Sampling

To assess the presence of soil contamination in the areas adjacent to the acid plant, a total of 20 sampling locations will be established. Sampling will be done on a directed basis, concentrating on areas which have visual evidence of potential contamination, landfill areas, drainage areas, etc. The soils at the selected locations will be sampled from three depth intervals: 0- to 12 inches, 2- to 3 feet, and 4- to 5 feet.

Soil samples will be submitted for chemical analysis for metals from the upper and lower sampling intervals to assess the presence of metal contamination (primarily lead) in the shallow soils.

Explosives were not detected in the soil sample analyzed during the OBG investigation. However, because the area was used for explosive demolition, soil samples will be obtained from the upper and middle sampling intervals for analysis of explosives.

A low concentration of VOCs (toluene), below method detection limits, was detected in a soil sample from Area 6. To assess the presence of VOC contamination, one soil sample from 16 selected boreholes will be analyzed; the samples will be selected on the basis of field headspace analysis, as described in Section 3.1.4. Generally, the sampling locations will be selected to provide an assessment of the entire area.

Finally, up to six samples will be analyzed for semivolatile organic compounds in areas of distressed vegetation or stained soils; these areas were found north, west, and south of LaPlace, Inc.

No sampling will take place within the fenced area of LaPlace, Inc.

4.6.3.2 Monitoring Well Installation and Ground Water Sampling

To assess whether explosives found in Area 6A deep monitoring well MW-16 are from an upgradient source, a deep monitoring well (MW-44) will be installed upgradient (north) of the plant adjacent to MW-27. This well will be screened from a depth of approximately 24- to 34 feet below ground surface.

Ground water samples will be collected from the new well, from the four existing wells in Area 6 (MW-25, MW-26, MW-27, and MW-16), and from MW-34, located between Areas 5 and 6. These samples will be submitted for chemical analysis for VOCs, semivolatiles, pesticides, metals, explosives, cyanide, dithiane, oxathiane, and thiodiglycol.

The monitoring wells will be permitted, installed, developed, and sampled as described in the appropriate subsections of Section 3.0.

4.6.3.3 Surface Water and Sediment Sampling

Surface water and sediment samples will be collected from the following areas:

- Standing water at the end of the drainage ditch on the northwest side of the acid plant. A sheen was noticed on these waters.
- Standing water at the end of the drainage ditch on the west side of the plant. A sheen was noted on the waters in this area.
- Standing water near sulfur landfill area on the south side of the plant. The vegetation surrounding this water was a dark gray, in contrast to the tan-colored vegetation throughout most of the marsh area.

These surface water samples and sediment samples will be submitted for chemical analysis for VOCs, semivolatiles, pesticides, explosives, and metals.

4.6.4 Dames & Moore Initial Studies - Area 6B, 6B-North

4.6.4.1 Soil Borings/Sampling

To assess the nature and extent of potential contamination associated with Area 6B and 6B-north, 10 borings (three in Area B and seven in Area 6B North) will be advanced to a depth of 5 feet below ground surface. Soil samples will be collected at depths of 0- to 12 inches, 2- to 3 feet, and 4- to 5 feet. Soil samples will be submitted for chemical analysis for metals from the upper and lower sampling intervals; soil samples will be obtained from the upper and middle sampling intervals for analysis of explosives.

The samples from Area 6B will be obtained adjacent to the mound of soil/explosive residue. Additionally, one composite sample of the mound material, collected from depths of 0 to 5 feet and containing some of the peat-like material found during the site reconnaissance (refer to Section 4.6.2) will be analyzed for metals and explosives.

Sampling and analysis of Area 6B north will be performed as stated above for metal and explosive analyses. Because of evidence of landfilling in this area (surficial evidence consists primarily of pieces of asphalt concrete), the soil samples from Area 6B-north will also be analyzed for VOCs and semivolatiles. Additionally, one composite sample of the mound material will be analyzed as stated above for Area 6B.

4.6.4.2 Monitoring Well Installation/Ground Water Sampling

To assess the ground water quality in the vicinity of Area 6B-north, a shallow monitoring well (MW-45) will be placed near the bend in Black Ditch, on the eastern side of the ditch. The well will be screened from a depth of approximately 5- to 15 feet below ground surface. A well at this location will provide downgradient ground water quality information for Area 6B North and also will provide additional downgradient water quality information for Area 5.

A ground water sample will be collected from the newly installed shallow wells for analysis of VOCs, semivolatiles, pesticides, cyanide, metals, explosives, diathiane, oxathiane, and thiodiglycol; analyses for the latter three compounds will be performed because the wells are downgradient of Area 5.

These monitoring wells will be permitted, installed, developed, and sampled as described in the appropriate subsections of Section 3.0.

4.6.4.3 Surface Water Sampling

As presently envisioned, no surface water samples will be collected in Areas 6B or 6B-north.

4.6.5 Area 6 Field Effort Summary

The following table presents a summary of Dames & Moore's field investigation activities, analytical parameters, and justification for performing them.

DAMES & MOORE - AREA 6		
ACTIVITY	**PARAMETERS**	**REASON**
UXO Survey	Subsurface Ordnance	A UXO search will be conducted to clear the area prior to any invasive activities. If anomalies are detected, no drilling will be performed in the suspect area.
Soil Borings/Sampling - Area 6A 20 borings in areas with visual contamination Sampling depth: 0-12", 2-3', 4-5'	VOCs (approximately 16 samples) Semivolatiles (6) Metals (40) Explosives (40)	Explosives were detected in a deep ground water sample; obvious signs of contamination were present around the acid plant. This activity will help determine the horizontal and vertical extent of the contamination.

DAMES & MOORE - AREA 6		
ACTIVITY	**PARAMETERS**	**REASON**
Area 6B 3 borings Sampling depths: 0-12", 2-3', 4-5'	Metals Explosives	Obvious signs of contamination are present.
Area 6B-north 7 borings Sampling depths: 0-12", 2-3', 4-5'	VOCs Semivolatiles Metals Explosives	Obvious signs of contamination are present. Possible past use of the area as a landfill.
Monitoring Well Installation and Ground Water Sampling - Area 6A 1 new upgradient deep well 4 existing wells (3 shallow, 1 deep) 1 shallow downgradient well	Metals, Cyanide, VOCs, Semivolatiles, Explosives, Dithiane, Oxathiane, and Thiodiglycol Pesticides	Explosives were detected in a deep ground water sample collected by OBG. This activity will help determine if explosives, or other contamination, is present in area and/or upgradient ground water samples.
Surface Water and Sediment Sampling - Area 6A A minimum of three sediment and surface water: * north side of plant * west side of plant * south side of plant - Area 6B none	VOCs, Semivolatiles, Metals, Explosives, Pesticides	Signs of contamination have been observed on the surface of standing water around the LaPlace acid plant. This activity is to assess the general quality of the surface water and sediments surrounding the plant.

4.7 AREA 7

4.7.1 Background and Previous Studies

OBG reported that Area 7 was used as a TNT melt-out and small arms popping plant. The time frame for this use was not reported by OBG, but the area was being used during the Arsenal close-out period for the destruction of various ammunition components containing less that 600 grains of explosives. OBG further reported that the area was contaminated with TNT, various ammunition components from small arms, and small amounts of explosives.

Within Area 7, trenches and sewer lines were excavated and cleaned of ammunition by LEAD during the 1963 decontamination effort; the exact locations of the trenches and sewer lines are unknown. During this decontamination approximately 7,000 yards of soil were removed. The potential hazards in this area include ammunition components buried beneath the surface, and soil and ground water contamination from explosives and heavy metals. The sump at building S-810 had been backfilled previously with soil and was suspected to be heavily contaminated; this 30-ft by 15-ft area was fenced and recommended for "Non-Use." The remainder of Area 7 was recommended for "Unrestricted Use."

OBG performed a contamination evaluation in 1987-1988; the majority of Area 7 was listed as medium-low priority, while the sump area was listed as a high priority site. The elements of OBG's field investigation and a summary of their findings are presented below:

OBG - AREA 7	
INVESTIGATION	**RESULTS**
UXO Search - spot and visual checks	None found
Geophysical Survey Magnetometer/GPR - altered grid	Evidence of TNT pit
3 Soil Borings to a depth of 6 feet Samples collected from: 0-5 feet, 5-10 feet, and 10-15 feet	- VOCs detected below action levels - potential contamination - Metals detected below action levels - potential contamination

OBG - AREA 7	
INVESTIGATION	**RESULTS**
3 Monitoring wells installed and ground water samples collected: MW-10, MW-11, and MW-12	- VOCs - ND - Metals detected below MCLs in effect at that time - TRPH - ND - Explosives - ND

4.7.2 Site Reconnaissance and Observation

This area has been developed, primarily with PSG&E buildings, landscaped areas, and paved and unpaved parking/storage areas. No areas of surface water were observed during the site reconnaissance; monitoring wells MW-10, MW-11, and MW-12 were located. The 30 x 15-foot fenced area was not found during the reconnaissance.

Based upon the results from the OBG soil analyses from boring B-7, it is possible that the sump in Building S-810 contained product other than TNT. B-7, a composite soil sample from a depth of 0-5 feet, contained 6 ppb benzene, 51 ppb chlorobenzene, and 109 ppb xylenes; this sample was not analyzed for explosives. It also is possible that site development activities, unrelated to arsenal activities, may have resulted in soil contamination; it would not be unusual to detect low concentrations of benzene and xylenes (constituents of gasoline) in a parking lot.

A review of several drawings (D-418 dated November 1, 1958, and D-84 dated October 10, 1949) indicated the area was part of a system known as the "Renovation Area." Building 810 appears to be labeled as Barricade Building S-11 on these drawings. Several TNT tanks are shown west of S-11, within the present Area 7.

Ground water samples collected from downgradient well MW-11 had matrix interference for explosives analyses and the indicator compound; chloride was detected at a concentration of 130 ppm. Ground water from monitoring wells MW-10 and MW-12 had concentrations of chloride at 34 ppm.

4.7.3 Dames & Moore Initial Studies

4.7.3.1 Soil Borings

To assess the extent of contamination in the soils, two borings will be advanced adjacent to the sump area and two borings will be advanced within the sump area. Samples will be collected at depths of 0- to 12 inches, 3- to 4 feet, 6- to 7 feet, and 9- to 10 feet. These soil samples will be submitted for chemical analysis for metals, VOCs, and explosives.

The above soil samples will be submitted for chemical analysis for metals from the 0- to 12 inches and 3- to 4 feet sampling intervals to assess the presence of metal contamination in the shallow soils.

Explosives were not detected in any soil samples analyzed during the OBG investigation. However, because the area was used for explosive demolition (the area was previously used to salvage explosives, and drawings indicated the presence of the TNT tanks), soil samples will be obtained from the 0- to 12 inches, 3- to 4 feet, and 9- to 10 feet sampling intervals for analysis of explosives.

Low concentrations of VOCs, below New Jersey action levels, were detected in soil samples from Area 7. To assess the extent of contamination, one soil sample from each borehole will be analyzed; selection of the sample will be based on field headspace analysis.

Although much of Area 7 has been developed and is covered with buildings, the eastern portion of Area 7 is presently used as an unpaved parking area. A 150-foot grid interval will be laid out over the parking lot; a soil gas survey will be performed by Tracer Research, Inc. at each grid node. The soil gas survey will only detect VOCs and is useful for selecting sampling locations only for this class of compound; we are unaware of any field screening techniques which will reliably detect other contaminants such as metals and explosives at the concentrations found during the previous OBG investigation. Soil samples will be obtained at two of the approximately 20 grid locations; the sample locations will be selected based on the highest soil gas readings. The samples will be collected at depths of 0- to 12 inches, 2- to 3 feet, and 4- to 5 feet. These samples will be submitted for chemical analysis for metals, explosives, and VOCs. Soil samples will be submitted for chemical analysis of metals from the upper and lower sampling intervals; soil samples will be obtained from the upper and middle

sampling intervals for analysis of explosives. The samples for VOC analysis will be selected on the basis of field headspace analysis.

If accessible, one boring will be placed in the area formally occupied by the TNT tanks.

4.7.3.3 Monitoring Well Installation and Ground Water Sampling

Ground water will be sampled from existing wells MW-10, MW-11, and MW-12; and from the upgradient well installed by Dames & Moore in Area 2 and Area 3. Ground water samples will be analyzed for VOCs, semivolatiles, pesticides, explosives, and metals.

Well development and sampling protocols are described in the appropriate subsections of Section 3.0.

4.7.4 Area 7 Field Effort Summary

The following table presents a summary of Dames & Moore's field investigation activities, analytical parameters, and justification for performing them.

DAMES & MOORE AREA 7		
ACTIVITY	**PARAMETERS**	**REASON**
UXO Survey	Subsurface Ordnance	A UXO survey will be conducted to clear the area prior to any invasive activities. If anomalies are detected, no drilling will be performed in the suspect area.
Soil Borings/Sampling adjacent to and in sump area; 4 samples to a depth of 10 feet (4 borings)	VOCs Metals Explosives	Metals and VOCs were detected in OBG samples. This activity will help determine the extent of contamination.
Soil Gas Survey - Grid (150-foot interval) Approximately 20 points	VOCs	To assess the extent of VOC contamination.

DAMES & MOORE AREA 7		
ACTIVITY	**PARAMETERS**	**REASON**
2 Borings Sampling depths: 0-12", 2-3', 4-5'	VOCs Metals Explosives	Based on soil gas survey.
Ground Water Sampling 3 existing wells	VOCs Semivolatiles Metals Explosives Pesticides	To help assess the quality of the ground water beneath Area 7

4.8 AREA 8

4.8.1 Background and Previous Studies

OBG reported that Area 8 was used as a storage area and a possible loading complex for small caliber ammunition and components. This area was in use from the early 1930s to the early 1960s; in the 1930s a fire and explosion scattered large grains of unburned gunpowder over the area.

Area 8 was decontaminated by disking the soil to a depth of 6-inches, hand raking, and surface burning in the 1963 decontamination effort by LEAD. This area then was recommended for "Unrestricted Use." The potential hazards identified for this area are unexploded ammunition and explosives below the depth of decontamination, and possible contamination of the soil and ground water from explosives and heavy metals.

OBG conducted a contamination evaluation in 1987-1988. Area 8 was listed as a low priority site. No investigation beyond a records search was conducted by OBG.

4.8.2 Site Reconnaissance and Observation

Area 8 has been completely developed and/or disturbed. A building and asphalt parking areas have been constructed atop fill material, and cover the majority of the area. Behind the building (to the south) is a large excavated area used for storm water retention, and a large mound (more than 15 feet high) of fill material. Beyond this soil mound is a natural area of

trees and marsh/standing water. Further to the south-southeast, an area was noted on an aerial photograph as a suspected landfill, probably from current development activities. This area was not visually assessed during the site reconnaissance; however, because of its location adjacent to Area 8, it is introduced in this section.

4.8.3 Dames & Moore Initial Studies

4.8.3.1 Soil Borings/Sampling

Sampling does not appear to be warranted because of the completely disturbed condition of the area; the soils are not representative of the conditions at the time of the LEAD decontamination activities.

4.8.3.2 Monitoring Well Installation and Ground Water Sampling

No monitoring wells are planned for this area. However, a limited soil gas survey will be performed in the area downgradient of the potential landfill. Up to five potential well locations will be surveyed. If evidence of contamination is detected by the survey, one shallow monitoring well will be installed. Water samples will be analyzed for VOCs, semivolatiles, pesticides, metals, and explosives.

The monitoring well will be permitted, installed, developed, and sampled as described in the appropriate subsections of Section 3.0.

4.8.3.3 Surface Water and Sediment Sampling

A surface water and sediment sample will be collected from the area of standing water described in Section 2.8.2. Runoff from the soil mound appears to drain into this area; the sample will help assess the quality of the surface water runoff from Area 8. These samples will be analyzed for metals, explosives, pesticides, and semivolatiles.

4.8.4 Area 8 Field Effort Summary

The following table presents a summary of Dames & Moore's field investigation activities, analytical parameters, and justification for performing them.

DAMES & MOORE - AREA 8		
ACTIVITY	**PARAMETERS**	**REASON**
UXO Survey	Subsurface Ordnance	A UXO search will be conducted to clear the area prior to any invasive activities. If anomalies are detected, no drilling will be performed in the suspect area.
Monitoring Well Installation and Ground Water Sampling Possible installation of a shallow well south of potential landfill area, depending on the results of a soil gas survey	VOCs Semivolatiles Metals Explosives Pesticides	No ground water sampling was conducted by OBG. This activity is to help assess the potential ground water contamination associated with Area 8 and the landfill area.
Surface Water and Sediment Sampling - 1 in marshy area south-southwest of Area 8	Metals Explosives Semivolatiles Pesticides VOCs	This activity will give an indication of water quality from Area 8 since it appears that runoff from the soil mound flows in the direction of this area of surface water.

4.9 AREA 9

4.9.1 Background and Previous Studies

Area 9 was used as a magazine area in the early 1940s. Various grades of explosives and ammunition were reported to have been stored in the magazine buildings. Magazine building H-65 exploded in 1943 scattering French Naval Ammunition, smokeless powder, and scrap throughout a large area.

A decontamination effort performed by LEAD in 1963 included surface soil disking (6-inch depth) surface burning, and sweeping for mines. LEAD previously divided Area 9 into two

parts; I and II (see Figure 2). Part I of Area 9 was surface burned, disked to a depth of approximately 6 inches below the surface and then surface-burned again. Part II also was cleaned, and swept for mines with a detector. The sweep indicated the possibility of live ammunition buried beyond the detection limit of the mine detector. Part I was recommended for "Unrestricted Use" by LEAD and Part II was recommended for "Surface Use Only." The remainder of Area 9 reportedly carried no restrictions.

The OBG report of February 1990 indicated that Area 9 has been heavily developed by Summit Associates with the exception of Part II. The GSA deeded Area 9 to Federal Storage Warehouses in 1965. The OBG report also stated that Part II was swept with metal detectors in 1987, by UXB International, revealing some scrap metal and live shells; the debris reportedly was removed.

According to the OBG report, the remaining potential hazards and contamination in Area 9 include subsurface explosives, and contamination of the soil and ground water in the area from explosives, explosive residues, heavy metals, and oils. The oil contamination reportedly occurred in 1980; a present site tenant, occupying a portion of the northwestern corner of Area 9, had a large oil spill. The oil apparently contained PCBs and subsequently was cleaned by order of the USEPA.

The elements of OBG's field investigation, and a summary of their findings, are presented below.

OBG - AREA 9	
INVESTIGATION	**RESULTS**
2 Ordnance Searches	1987 - LEAD mine detector sweep on Part II. Sweep indicated possibility of buried ammunition below the detection capability of the mine detector. Located scrap metal and live shells that were removed. 1988 - OBG contamination evaluation: UXB International performed a visual inspection and made spot checks with an ordnance indicator - none detected.

OBG - AREA 9	
INVESTIGATION	**RESULTS**
3 Ground Water Monitoring Wells MW-4, MW-5, MW-6	VOCs detected (MW-4) 1,1-dichloroethylene - 26 ppb 1,1-dichlorethane - 220 ppb Trichloroethylene - 280 ppb Benzene - 16 ppb Metals detected below MCLs in effect at that time. TRPH - 5 ppm Explosives - none detected
3 Surficial Soil	VOCs - None detected Metals - below NJ Action Levels Explosives - none detected
3 Soil Borings Each boring drilled to 15.0' Samples obtained from 0-5', 5-10', 10-15'	VOCs - below NJ Action Levels Metals - below NJ Action Levels Explosives - not conducted

4.9.2 Site Reconnaissance and Observation

Area 9 is developed with buildings, parking, landscaped areas, and roadways. An aerial photograph was referenced to correlate the dimensions of Area 9 with present-day features and structures; Figure 2 depicts the site as it is developed today. Of the three monitoring wells installed in or near Area 9 by OBG, only one, MW-6, was located by Dames & Moore. Because of the development of the area, the other two wells probably have been removed.

4.9.3 Dames & Moore Initial Studies

4.9.3.1 Soil Borings

All of Parts I and II in Area 9 have now been developed; additional soil sampling does not appear to be warranted.

4.9.3.2 Monitoring Well Installation and Ground Water Sampling

Based on DOD activities conducted at the site, it is considered unlikely the VOC contamination detected in MW-4 would have its source in Areas 9 or 10. Therefore, one monitoring well cluster (MW-46A & B) will be installed upgradient of Areas 9 and 10 to assess the quality of ground water leaving Area 18, the EPA/GSA area located upgradient of Areas 9/10. This cluster will be installed along the railroad tracks which separate the EPA/GSA area from the Raritan Center area. The two monitoring wells within the cluster will be installed within approximately 5 feet of each other. The shallow well will be drilled to a depth of approximately 15 feet and screened approximately from 5 to 15 feet; the deep well will be drilled to a depth of approximately 25 feet and screened from 15 to 25 feet. This cluster will provide the means to monitor a continuous ground water column and will assess the depth of the flow of contamination (if any) in the ground water table.

Additionally, Dames & Moore will install a well cluster (MW-47A & B) near the former location of MW-4, and a well cluster (MW-48A & B) approximately 1,200 feet south-southeast (downgradient) of MW-4. The location of this latter well cluster will be based on the results of a soil gas survey to be conducted by Tracer Research, Inc. Up to 50 sample locations are anticipated to assess the presence/extent of VOC contamination upgradient and downgradient of Area 9. Soil gas survey locations will be centered on the location of MW-4 and proceed radially from this location at approximately 300-foot intervals; the exact spacing of the holes will be based to a large extent on access in this heavily developed area. The survey will consider upgradient, downgradient, and side gradient directions. Decisions on the placement of additional soil gas survey holes at greater distances from MW-4 will be based on the analyses of the soil gases from locations closer to MW-4 along a common radial line.

Dames & Moore will also sample existing monitoring well MW-6.

The monitoring wells will be permitted, installed, developed, and sampled as described in the appropriate subsections of Section 3.0.

4.9.4 Area 9 Field Effort Summary

A summary of the proposed Dames & Moore field efforts for Area 9 is described below.

DAMES & MOORE - AREA 9		
ACTIVITY	**PARAMETER**	**REASON**
UXO Survey	Subsurface Ordnance	A UXO search will be conducted to clear the area prior to any invasive activities. If anomalies are detected, no drilling will be performed in the suspect area.
Ground Water Sampling Monitoring Well Installation and 1 Cluster monitoring well (shallow/deep) upgradient of Areas 9 and 10. 1 Cluster monitoring well near former MW-4. [Screened 5-15(shallow) and 15-25(deep)]	VOCs Semivolatiles Metals Explosives Pesticides	VOCs were detected in ground water samples near Area 9. This activity will assess the general quality of subsurface soils.
1 cluster monitoring well to be located downgradient of former MW-4, based on soil gas survey. Sample existing well MW-6	VOCs Semivolatiles Metals Explosives Pesticides	The downgradient wells will monitor the flow of contamination downgradient of MW-4
Soil gas survey - Up to 50 points	VOCs	To assess the extent of VOC contamination around MW-4

4.10 AREA 10

4.10.1 Background and Previous Studies

A records review and a subsequent site inspection conducted by OBG indicated that Area 10 contained ammunition magazines, and was used for the depriming of cartridge cases from the mid-1920s to post WWII. An explosion in the 1920s destroyed six magazines; the blast apparently scattered various caliber cartridge cases and miscellaneous components over an area now designated as Parts I and II (refer to Figure 2). During the 1963 decontamination effort, LEAD surface cleaned Parts I and II, and several sections were disked to 6 inches below the surface. Parts I and II of Area 10 were recommended for "Surface Use Only" as reports indicated the likelihood of buried ammunition beyond the detection capabilities of the mine detector. The remainder of Area 10 was recommended for "Unrestricted Use". Much of Area 10, including Parts I and II, was transferred by deed to the County of Middlesex in 1964; the county has since established the area as a public park. The remainder of Area 10 was transferred by deed to Federal Storage Warehouse in 1965 with no restrictions.

According to OBG the potential hazards and contamination identified in this area include subsurface live ammunition along with contamination of soil and ground water from metals, explosives and explosive residues.

OBG did not perform any contamination evaluation in Area 10 because the current property owner did not provide permission in a timely manner to assess the area. UXB International, however, did perform a brief visual inspection of a currently undeveloped portion of Area 10 during the initial OBG site inspection. Spot checks with ordnance locators also were performed; these checks revealed only one ordnance fragment, identified as the remains of a 35-mm cartridge base, at a depth of 6 inches below the surface.

4.10.2 Site Reconnaissance and Observation

The section of Area 10 that is part of the Raritan Center Complex is fully developed, and the section that is part of Middlesex County property contains ball fields, parking areas, park land, bike trails, and undisturbed area. Buildings 465, 466, and 467 are currently used by the county. Access to most of the county-owned section of Area 10 is open; however, some of the

undisturbed area is fenced, with a gate blocking the roadway. Most of Part I is currently undeveloped; most of Part II has been covered by a paved parking lot.

4.10.3 Dames & Moore Initial Studies

4.10.3.1 Soil Borings

Dames & Moore will establish a 100-foot interval grid to assess contamination in Parts I and II of Area 10. Soil borings will be advanced at each grid node to a depth of 2 feet. Composite samples from these borings will be analyzed for metals and explosives. A total of 20 borings are anticipated.

Soil boring drilling and sampling procedures are described in Section 3.0.

4.10.3.2 Monitoring Well Installation and Ground Water Sampling

One shallow monitoring well (MW-49) will be installed downgradient of Area 10, Parts I and II to assess ground water quality downgradient of the Middlesex College area. Ground water samples will be analyzed for VOCs, semivolatiles, pesticides, metals, and explosives.

The monitoring wells will be permitted, installed, developed, and sampled as described in the appropriate subsections of Section 3.0.

4.10.4 Area 10 Field Effort Summary

The following table presents a summary of Dames & Moore's field investigation activities in Parts I and II, analytical parameters, and justifications for their use. No investigation of the remaining portions of Area 10 are anticipated; the area has been completely developed and the soils are not considered to be representative of conditions that existed at the time of the decommissioning. Further, all portions of Area 10 other than Parts I and II were recommended by "Unrestricted Use" by LEAD during the 1963 decontamination effort.

DAMES & MOORE - AREA 10		
ACTIVITY	**PARAMETER**	**REASON**
UXO Survey	Subsurface Ordnance	A UXO search will be conducted to clear the area prior to any invasive activities. If anomalies are detected, no drilling will be performed in the suspect area.
Soil Borings: 20 boreholes based on a 100-foot grid; composite samples from depths of 0- to 2 feet	Metals Explosives	No soil analyses were performed by OBG. The study will provide information in areas thought to have the highest potential for contamination (Parts I and II)
Monitoring Well Installation Ground Water Sampling - Install one shallow well	VOCs Metals Explosives Semivolatiles Pesticides	The shallow monitoring well will provide data concerning ground water contamination downgradient of Area 10, Parts I and II.

4.11 AREA 11

4.11.1 Background and Previous Studies

Area 11 is primarily undeveloped marshland and generally is situated adjacent to and west of the patrol road along the Raritan River dock area. The OBG site investigation revealed that Area 11 consists of dredged soils from the Raritan River channel; the timeframe of this activity is unknown. According to an OBG records review, the area is contaminated with grenades, mortar shells, and small arms components.

Initially, LEAD partially cleaned Area 11 with a drag line and then searched it with a mine detector. LEAD then fenced a small area and recommended this space for "Non-Use" (see Figure 2). The rest of Area 11 was designated as "Unrestricted Use".

OBG's initial site inspection of Area 11 included a subsurface ordnance search, performed by UXB International in January 1988, and a brief ground surface inspection. UXB's survey revealed numerous small objects below grade within the previously fenced portion of the area. No ordnance was identified on the ground surface.

UXB conducted a geophysical survey in June 1988. The ordnance locators identified 20 metal objects below grade; excavation of these objects showed that they were not ordnance-related. According to OBG the potential hazards and contamination that exists within Area 11 include subsurface unexploded ammunition, grenades and mortar shells, and contamination of the soil and ground water from explosives and heavy metals. A summary of the previous investigation of Area 11 and the results are presented below:

OBG - AREA 11	
INVESTIGATION	**RESULTS**
2 UXO Searches Ordnance locators	No. 1 No surface objects found. Spot checks with ordnance locator of the subsurface revealed numerous small objects within the fenced portion of the site.
Magnetometer and GPR	No. 2 No surface objects found. Geophysical and GPR survey indicated the presence of 20 buried metal objects. Objects determined to be non-ordnance-related.
3 Surficial Soil	VOCs - Below NJ Action Levels Metals - Below NJ Action Levels Explosives - ND
Soil Borings	N/A

OBG - AREA 11	
INVESTIGATION	**RESULTS**
Ground Water 3 shallow monitoring wells: MW-28, MW-29, MW-30	VOCs - ND Total Metals - Below MCLs TRPH - ND Explosives - ND

4.11.2 Site Reconnaissance and Observation

Area 11 is located along Dock Road and contains approximately 6.65 acres. It is substantially covered with tall marsh grasses, although the strip adjacent to the road has been graded and is devoid of vegetation. There is standing water in this roadside area. On the northeast end are a series of mounds; the contents of these mounds are unknown. Most of Area 11 obviously has been filled. At the southwest end of the area, near the ready mix plant, is a small ditch which drains into a larger creek which trends northwest/southeast; a sheen was observed on the water of the small ditch.

4.11.3 Dames & Moore Initial Studies

4.11.3.1 Soil Borings

A total of 10 soil samples will be obtained for chemical analysis from 10 borings advanced at pre-determined locations across the site. Boreholes will be advanced to a depth of 5 feet or to the depth of ground water; a composite sample will be obtained from each borehole. Soil samples will be analyzed for semivolatiles, metals, pesticides, PCBs, and explosives. A discrete sample, selected on the basis of headspace analyses, will be analyzed for VOCs. Analyses for pesticides and PCBs are suggested because the area has been backfilled with sediments from the river; the heavy industrial use of the areas along the river indicates that a potentially wide range of contamination may be present in the dredged sediments.

Drilling and sampling of soil borings are described, in detail, in Section 3.0.

4.11.3.2 Monitoring Well Installation and Ground Water Sampling

At this time, no additional monitoring wells are anticipated for this area. If soil sampling indicates the presence of contamination, the installation of monitoring wells will be discussed with the USACE. Sampling of the existing shallow wells (MW-28, MW-29, and MW-30) will be performed; these monitoring wells provide sufficient coverage of the former fenced portion of Area 11 with respect to monitoring the up- and downgradient flow of ground water contamination (if any). These water samples will be analyzed for VOCs, semivolatiles, pesticides, metals, and explosives.

The existing monitoring wells will be sampled as described in the appropriate subsections of Section 3.0.

4.11.3.3 Surface Water and Sediment Sampling

Dames & Moore proposes to obtain one surface water and sediment sample adjacent to the northwest/southeast trending creek at the confluence of the ditch utilized by the ready mix plant. As noted in the site reconnaissance section, a sheen was present on the surface water in this area. The water will be analyzed for VOCs, semivolatiles, metals, and explosives; the sediment sample will also include analyses for pesticides and PCBs. Surface water and sediment sampling procedures are described in Section 3.0 of this plan.

4.11.3.4 Surficial Soil Sampling

A single surface soil sample will be obtained within an area northwest of Building 737; a sheen was noted on a small area of standing water (rainfall) in this area.

4.11.4 Area 11 Field Effort Summary

The following table presents a summary of Dames & Moore's field investigation activities, analytical parameters, and justification for performing them.

DAMES & MOORE - AREA 11		
ACTIVITY	**PARAMETER**	**REASON**
UXO	Subsurface Ordnance	A UXO search will be conducted to clear the area prior to any invasive activities. If anomalies are detected, no drilling will be performed in the suspect area.
Surface Water and Sediment Samples. 1 set of samples obtained at the confluence of the main creek, which trends northwest through Area 11, and the drainage ditch that services the ready mix plant.	VOCs Semivolatiles Metals Explosives (Sediment sample will also be analyzed for pesticide and PCBs)	A surface water sheen was noted in this area during the site reconnaissance. Sampling this confluence will monitor the downstream flow from the creek and the service ditch.
Soil Boring/Sampling - 10 boring locations across Area 11; composite sample 0-5 feet; boring depth 5 feet.	VOCs (a discrete sample, based on headspace analysis) Semivolatiles Metals Pesticides PCBs Explosives	No previous soil borings were placed in Area 11; surficial soil samples detected VOCs and metals. The area is reportedly backfilled with sediments from the Raritan River.
Surficial Soils 1 sample obtained northwest of standing water at building 737 (Figure 2).	VOCs Metals Explosives Semivolatiles Pesticides PCBs	Possible surficial soil contamination was noted during the site reconnaissance.

DAMES & MOORE - AREA 11		
ACTIVITY	**PARAMETER**	**REASON**
Ground Water Sampling - Existing shallow monitoring wells MW-28, MW-29, and MW-30	VOCs Metals Semivolatiles Explosives Pesticides	Previously, the existing wells contained metals below NJ action levels. The possibility of contamination in this area exists because of the potential presence of ordnance and contamination from dredged sediments.

4.12 AREA 12

4.12.1 Background and Previous Studies

Area 12 is an undeveloped marsh, overgrown with tall reed grass, located in the southernmost portion of the former arsenal. It has been reported that dredged spoils from the Raritan River channel dock area were dumped in this area; the time frame of this activity is unknown.

The area originally was inspected by representatives from the Army Material Command Safety Office and Raritan Arsenal personnel during the 1963 decontamination project. LEAD recommended Area 12 for "Unrestricted Use."

According to OBG's file search, a small cleared area toward the eastern end of Area 12, consisting of approximately 0.5 acre, was used by the New Jersey Department of Transportation (DOT) in the early 1980s for explosives testing; the cleared area reportedly was still free of vegetation.

A study was performed on Area 12 by the United States Army Corps of Engineers (USACE) in 1984 and 1985. The southern section of Area 12 was being investigated for a proposed land disposal site for dredged river channel spoils from shipping channels in New York and New Jersey ports. The USACE reportedly installed 14 wells and advanced six borings as part of the investigation; the well locations were not found during Dames & Moore's site reconnaissance. The results of this study are not known by Dames & Moore.

According to OBG, the potential hazards and contamination in Area 12 are explosives and explosive residues resulting from DOT explosive testing, and heavy metals and pesticides in the soil and ground water. The potential for pesticide contamination is the result of a former pesticide blending operation during the 1980s in Buildings 651 and 652 of Area 16 (north-northwest of Area 12). OBG indicated that they took no further action in this area with the exception of a site reconnaissance; nothing unusual was mentioned in the report.

4.12.2 Site Reconnaissance and Observation

Area 12 is undeveloped marsh land covered with tall grasses. Its southern edge meets the Raritan River, and a former patrol road follows the river bank. Approximately 1/4 mile west of March Road, along the patrol road, is a driveway into a clearing where an area devoid of typical tall grasses was observed; this area is assumed to be the DOT area. It appears that dredge spoils had been placed at this location, as indicated by the presence of sediments and shells. Adjacent to the edges of the cleared area was standing water; a sheen was observed on the surfaces of some of this water.

It is our understanding the former DOT area is currently being used for the detonation of ordnance; no investigations will be performed in this area until these activities have been completed.

4.12.3 Dames & Moore Initial Studies

4.12.3.1 Soil Borings

Soil sampling in the DOT testing area will be based on a grid with 50-foot centers. A total of 16 samples are anticipated. Three samples from each boring will be obtained from intervals of 0- to 12 inches, 2 to 3 feet and 4 to 5 feet.

The above soil samples will be submitted for chemical analysis for metals from the upper and lower sampling intervals to help determine the extent of metal contamination in the shallow soils.

Because the area was used for explosive demolition, soil samples will be obtained from the upper and middle sampling intervals for analysis of explosives.

Dames & Moore drilling and sampling procedures for subsurface soils are described in applicable subsections of Section 3.0.

In those portions of Area 12 not associated with DOT testing, 10 sample locations will be randomly sampled. The method of sampling consists of dividing the area into approximately 100 sections. Through the use of a random number generator, 10 sections will be selected for analysis. The sample locations within the section will be as close to the center of the section as conditions at the site permit. The soil borings will be advanced to a depth of 5 feet or to the depth of ground water, whichever occurs first. Composite soil samples will be collected from depths of 0- to 5 feet and will be analyzed for semivolatiles, metals, pesticides, PCBs, and explosives. A discrete sample, selected on the basis of headspace analyses, will be analyzed for VOCs. Analyses for pesticides and PCBs are suggested because the area has been backfilled with sediments from the river; the heavy industrial use of the areas along the river indicates that a potentially wide range of contamination may be present in the dredged sediments.

4.12.3.2 Monitoring Well Installation and Ground Water Sampling

At this time, no additional monitoring wells are anticipated for this area. If soil sampling indicates the presence of contamination, the installation of monitoring wells will be discussed with the USACE.

4.12.3.3 Surface Soil Sampling

Further visual inspection of the surface soils will be performed in Area 12 during the drilling and sampling phase of the investigation. If areas of suspect surface contamination are found, the USACE will be notified prior to performing additional work.

4.12.3.4 Area 12 Field Effort Summary

The following table presents a summary of Dames & Moore's field investigation activities, analytical parameters, and justification for performing them.

DAMES & MOORE - AREA 12		
ACTIVITY	**PARAMETER**	**REASON**
UXO Search	Subsurface Ordinance (Explosives)	The area is suspected of containing ordinance and contaminated dredged spoils from the Raritan River Channel. A small portion (1/2 acre) has been, and is being, used for ordnance detonation. A UXO search will be conducted to clear the area prior to any invasive activities; if any anomalies are detected, no drilling will be performed in the suspect area.
Soil Borings (DOT Testing Area) - Grid at 50-foot centers - Sample 0-12", 2-3' and 4-5' Below the surface; 16 borings (to be performed after current detonation activities have been completed)	Metals Explosives	The area has been/is being used for explosives detonation.
Soil Borings (not in DOT Testing Area). - Area divided into 100 sections; 10 sections selected at random. Borings to 5 feet or ground water; composite soil samples from 0-5'	VOCs (discrete samples) Semivolatiles Metals Pesticides PCBs Explosives	The possibility of contamination exists because of the potential presence of contamination in the sediments dredged from the river.
Surficial Soils - Visual Inspection	Unknown	A visual inspection of surficial soil within Area 12 will be conducted during the drilling and sampling phase of the Former Raritan Arsenal. If any suspected areas of contamination are noted, the USACE will be notified prior to sampling.

4.13 AREA 13

4.13.1 Background and Previous Studies

Area 13 was part of the LEAD decontamination effort of 1963. LEAD recommended no restrictions on this area. Figure 2 depicts the location of Area 13.

Area 13 consists of the dock area. The OBG report states that the area has possible ammunition lodged in the bottom of the river, under and adjacent to the dock area. The OBG report also states that USACE dredged this area of the river at the dock to a depth of approximately 27 feet; records do not indicate where the dredged spoils were placed. With the exception of a record search and site reconnaissance, no work was done in Area 13 by OBG because of its low priority.

4.13.2 Site Reconnaissance and Observation

The dock is constructed of railroad ties and has been extensively damaged; the spacing between the ties could allow small items to fall into the water beneath the dock.

4.13.3 Dames & Moore Initial Studies

Although there is a possibility that ordnance may still exist in the river sediments adjacent to and underneath the dock, the Huntsville Division of the Corps of Engineers is responsible for the detection of ordnance at the site. Dames & Moore, therefore, will not conduct any additional investigations in this area.

4.14 AREA 14

4.14.1 Background and Previous Studies

Area 14 is a large area in the easternmost portion of the former Raritan Arsenal (Figure 2). The area reportedly was filled with dredged spoils from the Raritan River channel. The OBG records review indicated that no activities, with the exception of the disposal of dredge spoils, occurred in this area; the time frame in which the deposition of the spoils occurred is unknown. A representative of the Army Material Command Safety Office, and Raritan Arsenal

personnel, recommended the area for "Unrestricted Use" during the 1963 decontamination effort. Due to the low priority given to Area 14, OBG performed no field investigations.

4.14.2 Site Reconnaissance and Observation

Area 14 is undeveloped and mostly devoid of vegetation, although there are some areas with trees, bushes, and low grasses. Dumping of general household effects and wrecked automobiles has taken place sporadically throughout parts of Area 14.

Additionally, approximately 5 percent of the area has been used for landfilling soils removed during development of Raritan Center. No other signs of obvious contamination were observed.

4.14.3 Dames & Moore Initial Studies

4.14.3.1 Soil Borings/Sampling

Dames & Moore proposes to perform a contamination evaluation of Area 14 by obtaining soil samples from within selected sections of Area 14. The proposed method of soil sampling consists of dividing the area into 100 sections. Through the use of a random number generator, 10 sections will be selected for placement of soil borings to collect soil samples. The soil boring location within each section will be as close to the center of the section as conditions at the site permit. Soil borings will be advanced to a depth of 5 feet or to the depth of ground water, whichever occurs first. Composite samples will be collected from depths of 0- to 5 feet and will be analyzed for semivolatiles, metals, pesticides, PCBs, and explosives. A discrete sample, selected on the basis of headspace analyses, will be analyzed for VOCs. Analyses for pesticides and PCBs are suggested because the area has been backfilled with sediment from the river; the heavy industrial use of the areas along the river indicates that a potentially wide range of contamination may be present in the dredged sediments.

4.14.3.2 Monitoring Well Installation and Ground Water Sampling

Dames & Moore will install one shallow monitoring well (MW-50) in the downgradient portion of Area 14; the location of the well will be based on a soil gas survey. A water sample

will be analyzed for VOCs, semivolatiles, pesticides, metals, and explosives. The approximate location of the monitoring well is shown in Figure 2.

The monitoring well will be permitted, installed, developed, and sampled as described in the appropriate subsections of Section 3.0.

4.14.3.3 Area 14 Field Effort Summary

The following table presents a summary of Dames & Moore's field investigation activities, analytical parameters, and justification for performing them.

DAMES & MOORE - AREA 14		
ACTIVITY	**PARAMETER**	**REASON**
UXO Survey	Subsurface Ordnance	A UXO search will be conducted to clear the area prior to any invasive activities. If anomalies are detected, no drilling will be performed in the suspect area.
Soil Sampling - Divide Area 14 into approximately 100 sections. Through a random number generator, 10 sections will be selected and sampled. - Composite soil samples from each selected section will be obtained from intervals of 0 to 5 feet or to the depth of ground water (whichever is encountered first)	Semivolatiles Metals Pesticides PCBs Explosives VOCs (discrete sample from each interval selected by headspace analyses)	Selected sections and associated soil boring locations will provide enough initial information to assess the possibility of contamination in the soils at Area 14. No previous studies have been performed in this area.

DAMES & MOORE - AREA 14		
Monitoring Well Installation and Ground Water Sampling - One downgradient shallow well (screened 5- to 15 feet from the surface)	VOCs Semivolatiles Metals Explosives Pesticides	The downgradient well will monitor the flow of potential contamination through Area 14 and provide data concerning the hydrology of the area. No other investigations have been done in this area.

4.15 AREA 15

4.15.1 Background and Previous Studies

Area 15 consists of a pond area on the edge of the "Igloo" structures. The time frame in which these storage structures for explosives were used is unknown. Area 15 was recommended for "Unrestricted Use" by LEAD following the 1963 decontamination effort. It was not scheduled for re-evaluation during the OBG investigation because of the previous "rank" given to it by LEAD. It was determined later, in September 1988, that the area reported to be Area 15 may not have been the actual location. During excavating for a new building in 1976, several hundred yards from the assumed location of Area 15, buried ordnance was discovered. The ordnance consisted of rockets, grenades, and mines and was removed by the Army in 1977. Documentation was provided to OBG by FBC stating that the area previously remediated was not the actual Area 15. Based on the new information, it appeared that Area 15 never was decontaminated, and that buried debris, metal scraps, and small ammunition components still may be buried on site. The additional information elevated the "rank" of the area.

OBG reported that approximately 50 percent of the area had been developed by 1988. The other half consisted of small trees, shrubs, and mounds of fill. In 1989, approximately 25 percent of the undeveloped area had been excavated to make way for another new building. The excavation for this building site extended to a depth approximately 12 feet below grade, through the fill material to the original soil surface. During the excavation, about 50 shell casings (22 to 30 caliber size) were discovered; all appeared to be empty. The OBG report stated that the remainder of the undeveloped area was scheduled for excavation. The following table describes the events that took place, and the findings of the OBG Contamination Evaluations of 1987 and 1988.

OBG - AREA 15	
INVESTIGATION	**RESULTS**
3 UXO Searches - January 1988 UXB - August 1988 Consultant to current property owner - November 1988 UXB	A brief visual inspection revealed no apparent ordnance on the ground surface. Spot checks with an ordnance locator identified numerous small objects below the surface. No excavations were performed. Excavation of 53 test pits over most of the site. No indication of the presence of ordinance or other hazardous materials was reported. Prior to the OBG geophysical survey, a visual inspection revealed no surface contamination related to ordnance. Ordnance locators identified large and small objects below the ground surface. No hand excavations were performed.
Geophysical survey Magnetometer	EM survey identified a number of subsurface anomalies which may represent ferrous objects. Subsequent excavations for buildings revealed some objects that may have been the source of the magnetic anomalies.
Soil Borings - 3 soil borings B-31, B-32, and B-33 - Collected samples from each boring at intervals (0-5, 5-10, 10-15) below grade.	VOCs - ND Metals: Lead 276 ppm Explosives - ND Strong odor in B-32 at 12 foot interval
Ground Water - 3 monitoring wells MW-35, MW-36, and MW-37. Screened intervals 5-35 feet, 5-30 feet, and 14-34 feet, respectively	VOCs - ND Total Metals - Below MCLs TRPH - ND Explosives - ND
Surficial Soils - 5 surface soil locations	VOCs - ND Metals - Below action levels Explosives - ND

4.15.2 Site Reconnaissance and Observation

The entire site near Area 15 has been developed with warehouses (i.e., Shop-Rite, Universal), parking/storage lots, roadways, and/or landscaping. Monitoring wells MW-35, MW-36, and MW-37 were not located and probably have been removed.

4.15.3 Dames & Moore Initial Studies

As noted above, the site has been developed in and around Area 15. Dames & Moore proposes no further field exploration of the area due to the development that has already occurred, and the previous OBG findings. All of the OBG monitoring wells in this area have been removed.

4.16 AREA 16

4.16.1 Background and Previous Studies

The OBG records review and site inspection indicated that Area 16 consisted of magazine buildings which stored smokeless powder. It was reported that over 75 percent of these buildings still existed. LEAD recommended the area for "Unrestricted Use" after it was decontaminated in 1963; the area was supposed to have been contaminated with small grain powder. The GSA transferred this area in deed in 1965 to Federal Storage Warehouses with no restrictions.

The area has not been developed; however, many small business have utilized the magazine buildings over a period of time. Fire destroyed building 643 in 1985. During the subsequent demolition, 3,580 35-mm shells were found and removed from beneath the ground surface. In the 1980s, buildings 651 and 652 were used as a pesticide blending plant, and building 630 was used to store drums that were reported to have contained acids and petroleum products. The whereabouts of these drums is currently unknown.

OBG describes the area as mostly marshland. The buildings and associated railroad access are all raised above the marshland. According to OBG, the potential hazards and contamination at Area 16 include subsurface and surficial live ammunition and smokeless powder

down to the water table. OBG also noted that the corrugated magazine building siding is transite and may contain asbestos.

The following is a brief summary that describes the activities previously performed at Area 16 by OBG.

OBG - AREA 16	
INVESTIGATION	**RESULTS**
2 UXB Surveys - January 1988 UXB	The survey was performed during the initial site inspection. A visual inspection revealed no apparent ordnance on the ground surface. Spot checks with an ordnance locator revealed numerous unidentified small buried objects.
- June 1988 UXB	Visual inspection revealed numerous partially buried 35-mm projectiles identified as being live.

OBG did not perform any further field investigations pending ordnance removal.

4.16.2 Site Reconnaissance and Observation

The magazine buildings in Area 16 appear to be in poor condition; many were no longer present. The roads/railroads were constructed on fill material; the buildings were constructed on fill and/or pilings. The remainder of the area is marsh with tall grass. Several abandoned vehicles were observed to have "fallen" off the fill area into the marsh.

Access to non-filled areas by a drill rig is not possible. Buildings 651 and 652, where pesticide operations were reportedly located, are no longer standing but were at the end of magazine line 17. The next magazine line downgradient (ML-18) does not extend as far west as ML-17; therefore, access downgradient of former buildings 651 and 652 is limited.

4.16.3 Dames & Moore Initial Studies

4.16.3.1 Soil Borings/Sampling

Dames & Moore proposes to obtain soil samples from 9 boring locations. Three of the borings will be located adjacent to building 643; additional ordnance is currently being removed from this area. The location of the other six boreholes will be based on the results of an ordnance assessment by an Army unit from Huntsville, Alabama. Composite samples will be obtained at an interval of 0- to 5 feet or to ground water, whichever comes first. The composite samples will be analyzed for metals and explosives to assess contamination from activities formally conducted at the arsenal.

Soil boring and sampling procedures are provided in appropriate subsections of Section 3.0.

4.16.3.2 Monitoring Well Installation and Ground Water Sampling

Dames & Moore will install four monitoring wells (MW-51, 52A & B, 53) downgradient and one monitoring well (MW-54) upgradient of Area 16. Two of the monitoring wells will be installed as a shallow/deep cluster adjacent to Building 655. Because of the size of the area and limited accessibility, the monitoring wells will be installed along the access roads for the magazine buildings, as shown in Figure 2, except as follows: if site conditions permit, the upgradient well will be located on the west side of the creek located between ML-12 and ML-13, northwest of S609 (refer to Drawing D-418), to assess the presence of contamination from landfilling activities upgradient of this well. One of the wells will be installed to assess the presence of contamination adjacent to Building 652; this building once housed a pesticide blending operation.

The intent of the proposed wells is to monitor the flow of contamination (if any) into Area 16 from potential upgradient sources and to monitor the flow of contamination migrating through the area.

The monitoring wells will be permitted, installed, developed, and sampled as described in the appropriate subsections of Section 3.0.

4.16.3.3 Surficial Soil Sampling

The OBG report noted that magazine building 630 formerly was used as a storage facility for drums which reportedly contained acids and petroleum products. Dames & Moore will conduct a visual search of the building and the surrounding grounds for signs of surficial contamination. If areas of potential contamination are noted during the reconnaissance, an expanded sampling plan will be devised by Dames & Moore and submitted to the USACE for approval.

4.16.3.4 Area 16 Field Effort Summary

The following table presents a summary of Dames & Moore's field activities, analytical parameters, and justification for performing them.

DAMES & MOORE - AREA 16		
ACTIVITY	**PARAMETER**	**REASON**
UXO Search	Subsurface Ordnance	Potential of UXO in area adjacent to the magazine buildings. A UXO search will be conducted to clear the area prior to any invasive activities. If anomalies are detected, no drilling will be performed in the suspect area.
Soil Sampling - 3 borings around magazine Building 643. Composite sample from 0-5' or to ground Six borings will be based on an assessment by a Huntsville ordnance unit.	Metals Explosives	To assess contamination from DOD activities.

DAMES & MOORE - AREA 16		
ACTIVITY	**PARAMETER**	**REASON**
Monitoring Well Installation and Ground Water Sampling - 1 monitoring well upgradient of Area 16 - 4 monitoring wells downgradient of Area 16 (3 shallow, 1 deep)	VOCs Semivolatiles Metals Pesticides Explosives	The monitoring well locations are designated to monitor contamination migration (if any) from potential upgradient sources and migration through Area 16 downgradient. One well at magazine building 652 also will monitor the potential for localized pesticide contamination.
Surficial Soils Visual reconnaissance at building 630 (former drum storage building)	Visual Observation	Building 630 was reported to contain drums of acid and petroleum products. A visual assessment of surficial contamination will be performed.

4.17 AREA 17

4.17.1 Background and Initial Studies

Area 17 formerly was used as a property disposal and salvage storage area; the length of time that this area was used for these operations is unknown. Area 17 currently is owned by Middlesex County Community College. The College Student Center building was constructed over a portion of Area 17; the remainder of the area appears to be a landscaped area and a road. The OBG records review indicated that the area was contaminated with scrap metal and various ammunition components. LEAD removed all of the suspect contamination during the decontamination effort of 1963. This effort also included a surface search and surface scrapping to uncover ammunition items. No potential or suspect contamination was found and Area 17 was ranked for "Unrestricted Use." The county of Middlesex acquired the property by deed in 1964 with no restrictions.

The OBG study included further review of excavation and construction files of the development of the area; these files indicated no potentially hazardous articles were found. No further field investigation was performed by OBG at Area 17.

4.17.2 Site Reconnaissance and Observation

Area 17 is located on the Middlesex County Community College campus in the vicinity of a parking area, an ecological trail (undisturbed and undeveloped), roadways, the student center, and the physical education facility. No visible signs of contamination and no areas of surface water were noted during the reconnaissance.

It appeared that there is minimal use of the ecological trail; the area is covered with trees and brush. The remainder of soils associated with Area 17 probably were removed in constructing the roadway and the buildings.

4.17.3 Dames & Moore Initial Study

Based on the site reconnaissance and the OBG report, Dames & Moore proposes no further action at Area 17 except for an assessment of ordnance (by others). The area appears to have been completely disturbed; it is unlikely the soils are representative of the conditions existing in 1963.

4.18 AREA 17A

4.18.1 Burning Area

A review of Drawing D-418, dated 23 February 1954, indicated the presence of a burning area south of Area 17 (see Section 2.18.2). Dames & Moore will assess this area by conducting a soil gas survey using a 40-foot grid; the survey will be performed by Tracer Research Corporation, Inc., using an on-site gas chromatograph, as described in Appendix B. Composite samples for laboratory analysis will be obtained from depths of 0-5' from boreholes advanced adjacent to the six soil gas survey locations which had the highest VOC readings. Composite soil samples from each borehole will be analyzed for semivolatiles, metals, pesticides, and PCBs. VOC analysis will be performed on discrete samples from three of the six boreholes. The VOC sample locations will be selected by the results of the soil gas survey;

a discrete sample from each borehole will be selected by headspace analysis. Explosives will also be analyzed at the locations selected for VOC analysis.

Additionally, one ground water monitoring well cluster (MW-55A & B) will be installed downgradient of Area 17A.

DAMES & MOORE - AREA 17A (BURNING AREA)		
ACTIVITY	**PARAMETER**	**REASON**
UXO Search	Subsurface Ordnance	A UXO search will be conducted to clear the area prior to any invasive activities. If anomalies are detected, no drilling will be performed in the suspect area.
Soil Gas Survey - Over burning area (drawing D-418); 40-foot grid interval	Volatile Organic Compounds	To assess the presence of organic vapors as an indication of subsurface contamination.
Soil Borings/Sampling - 6 borings to a depth of 5 feet at locations adjacent to soil gas survey boreholes with highest readings; composite samples from depth intervals of 0-5 feet.	3 VOCs (from discrete sample) 6 Semivolatiles 6 Metals 6 Pesticides 6 PCBs 3 Explosives	To chemically analyze potential contamination in soils.
Monitoring Well Installation and Ground Water Sampling - 1 monitoring well cluster downgradient of Area 17A	VOCs Semivolatiles Metals Pesticides Explosives	To detect ground water contamination from Area 17A.

4.19 AREA 18 (GSA/EPA Area)

4.19.1 Other Areas of Concern

The OBG Contamination Evaluation focused only on those areas previously identified as contaminated or potentially contaminated. For the most part the contaminants of concern were related to ordnance; areas selected during the 1963 evaluation were used for the disposal of ordnance or were thought to contain UXO as the result of explosions or other accidents. Because no ordnance-related problems were known to exist in the former GSA area (now occupied by the USEPA), this area was not assessed by OBG.

There is a potential for contamination in this 350 acre portion of the site for several reasons, including the use of the area for maintenance activities, the presence of underground storage tanks, and the probable existence of landfills. Additional areas of concern include a "burning grounds" formerly located on what is now Middlesex County Community College, and the disposal of sludges and filter sands from the former on site sewage disposal system.

Area 18 will not be included in Dames & Moore's scope of work at this time because of an on-going study being conducted by the USEPA for the former GSA area. However, the "burning grounds" mentioned above will be included in Dames & Moore's scope of work; this area is currently not being assessed by the USEPA. The remainder of this Section 4.19 is included as an indication of the extent of work required to complete a preliminary assessment of the area. Area 18 investigations will be conducted during the second phase of this remedial investigation. The investigations will be based on USEPA assessments, the fact that solvents have been found in monitoring wells downgradient of Area 18, the potential for landfills, a site reconnaissance, and the following record/drawing review.

4.19.2 Drawing Review

During the site reconnaissance, a brief review was performed of the available drawings prepared for the Ordnance Corps; these drawings are currently available in the files of Federal Building Systems. Although these drawings were not sufficiently detailed for our purposes, several items of concern were noted, as described below.

Ordnance Corps
Office of Arsenal Facilities Division
Raritan Arsenal, New Jersey
General Plan
Dwg. No. D-418, dated 23 February 1954

- A reference to a "burning ground" was noted in the far west corner of the site. This area appears to be south of Area 17, on the Middlesex County Community College Campus, approximately in right field in the baseball area.

- A sewage disposal system was located in an area which is part of Area 10. The disposal of sludges and filter sands from this area is unknown.

- The list of warehouses on this drawing includes references to a publications and reproduction warehouse (potential problems from inks and cleaning solvents), a woodworking shop (paints, thinners, solvents), maintenance shops (oils, solvents), and an automotive shop (solvents and waste oils).

- The list of service buildings includes references to a locomotive roundhouse, a gasoline station (the pump is still installed in this area, across from the engine rebuild shop), and a storage area for gas, oil and paint (west of the locomotive roundhouse).

- The list of shops includes nine structures which have the potential for contamination from cutting fluids, hydraulic oils, and/or cleaning solvents; these shops include the small arms shop, machine shop, artillery shop, engine rebuild shop, combat vehicle processing shop, vehicle rebuild shop, etc.

- The list of garages includes a reference to a motor repair shop.

- The list of utilities includes references to four heating plants; at least one of these is known to have used at least two underground storage tanks.

Master Plan
Plans for Future Development
General Utilities
Electrical Distribution System (Primary)
dated 1 February 1960
Sheet 17 of 23

This drawing lists the locations of the transformers formerly used throughout the facility; more than 100 locations were shown, with transformers ranging in size from 2500 KVA to 7½ KVA. No attempt was made to visit each location during the site reconnaissance. However, it was obvious that many of these transformers have been removed. Because of the age of the plant, there is a possibility that some of these transformers contained dielectric fluids contaminated with PCBs; it is not known if some of these fluids entered the environment.

Master Plan
Plans for Future Development
General Utilities
Compressed Air and Gas and Fuel Oil Distribution System
dated 1 February 1960
Sheet 20 of 23

This drawing indicates the location of various fuel oil tanks, both aboveground and underground. It is possible that not all tanks are shown; for example, smaller tanks which might have provided heating fuel for the guardhouses or outlying shops or offices are not shown on this drawing. The drawing does not differentiate between aboveground and underground storage tanks. Many of the tanks are shown to contain #4 or #6 fuel oil; the potential for significant contamination from these materials is slight because of their high viscosity when unheated. However, several #2 fuel oil tanks are shown; this material is considerably more mobile in the environment than #4 or #6 fuel oil.

Raritan Arsenal
Map Showing Boundaries, Roads, Structures, Tracks
and Fire Alarm Systems, dated 1930
Sheet 2 of 15

This drawing indicates that a gasoline station was located at the corner of Williams Avenue and Pershing Avenue, between buildings L-17 and SW-21. It is not known if the underground storage tank(s) has been removed.

4.19.3 Site Reconnaissance - Area 18 (GSA/EPA Area)

A brief site reconnaissance of the GSA area was conducted as a part of the reconnaissance of the Raritan Arsenal. The only part of the GSA/EPA Area which was addressed by OBG was Area 1.

The site reconnaissance detected the presence of two potential disposal areas located in the general area north of Magazine Gate No. 1. Additionally, a small, shallow pond which contained several 55-gallon drums was found adjacent to Avenue D. Further, evidence of several underground storage tanks was noted. Finally, PCBs may be present at the facility, as evidenced by a sign on the door of the engine rebuild shop.

The following investigations appear to be appropriate:

- Underground Storage Tanks (USTs) -- Evidence of several USTs, used for the storage of gasoline and middle distillate fuel oils, were found at the site. Other USTs may have been used at the site for the storage of solvents, waste solvents and waste oil. Following a thorough drawing review, a visual assessment should be conducted of all areas which potentially contain USTs based on the prior use of the area. The visual assessment should be followed by an E-M survey to detect subsurface anomalies. Soils sampling and analysis should be conducted where appropriate.

- Shops, Warehouses, Undeveloped Areas -- The probable use of solvents in many of these buildings may have resulted in the release of contaminants to the environment. The use of an organic vapor analyzer (OVA) survey appears to be an appropriate method to begin an assessment of the presence of contamination in and adjacent to these buildings and undeveloped areas.

- Small, Manmade Pond -- An assessment of the small pond mentioned above should include sediment samples, surface and ground water samples, and soil samples to detect the presence and extent of contamination, if present.

- Landfill Areas -- Several potential landfill areas were noted during the site reconnaissance, including areas which contained visible drums and surface debris, vine-covered drums, and areas with unusual soil conditions and little or no vegetation. A review of historical aerial photographs, visual assessments, soil gas surveys, E-M surveys, and soil and ground water sampling and analysis appear to be appropriate for these areas.

- Potential PCB Areas -- Major substations in the GSA/EPA area should be visually assessed. Wipe samples and/or surficial soil samples should be obtained for analysis, as appropriate. Because of the past use of PCBs in various petroleum-based fluids (lubricants, hydraulic fluids, etc.)which may have been used at the site, shop areas also should be visually assessed, sampled and analyzed, as appropriate.

- Ground Water -- Ground water monitoring wells should be installed at appropriate locations to assess the presence and extent of ground water contamination.

4.19.4 Area 18 Field Effort Summary

The following tables present summaries of Dames & Moore's suggested field activities, analytical parameters, and the justification for performing them. Only the "Burning Area", discussed in Section 4.18, has been included in Dames & Moore's current scope of work in the following tables.

DAMES & MOORE - AREA 18 (GENERAL GROUND WATER)		
ACTIVITY	**PARAMETER**	**REASON**
UXO Search	Subsurface Ordnance	A UXO search will be conducted to clear the area prior to any invasive activities. If anomalies are detected, no drilling will be performed in the suspect area.
Monitoring Well Installation and Ground Water Sampling MWs along Woodbridge Avenue MWs in a line parallel with Casad Road	VOCs Semivolatiles Metals Pesticides PCBs TRPH Explosives	Woodbridge Avenue wells will help establish quality of upgradient ground water. Casad Road aligned wells will help assess presence of potential contamination of warehouse portion of GSA-site.

DAMES & MOORE - AREA 18 (ELECTRICAL SUBSTATIONS/SHOP AREAS)		
ACTIVITY	**PARAMETER**	**REASON**
Visual Assessment - Major substations in the GSA area - Undeveloped portions of remainder of arsenal - Shop areas	Signs of potential PCB contamination; obvious oil stains	The potential for PCB contamination exists as a result of electrical equipment and maintenance activities conducted at the site.

DAMES & MOORE - AREA 18 (ELECTRICAL SUBSTATIONS/SHOP AREAS)		
ACTIVITY	**PARAMETER**	**REASON**
Wipe Samples - Where visual signs of contamination/oil stains are observed - Wipe samples obtained by scrubbing 10-cm by 10-cm area with a hexane-soaked gauze	PCBs	The potential for PCB contamination exists in areas where visual signs of contamination are present.

DAMES & MOORE - AREA 18 (POTENTIAL LANDFILL AREAS)		
ACTIVITY	**PARAMETER**	**REASON**
UXO Search	Subsurface Ordnance	A UXO search will be conducted to clear the area prior to any invasive activities. If anomalies are detected, no drilling will be performed in the suspect area.
Visual Assessment and EM Survey - Northeast of building SB-11 near visible drums; grid interval to the extent possible - Areas with no vegetation, or unusual soil conditions - Vine covered landfill south of railroad tracks near building SS-7	Subsurface Anomalies	To attempt to define the landfill area.
Soil Boring/Sampling for each landfill area:	VOCs Semivolatiles Metals Pesticides PCBs TRPH	To help assess the presence of potential chemical contamination in subsurface soils associated with suspected landfill areas.

DAMES & MOORE - AREA 18 (POTENTIAL LANDFILL AREAS)		
ACTIVITY	**PARAMETER**	**REASON**
Monitoring Well Installation and Ground Water Sampling For each landfill area:	VOCs Semivolatiles Metals Pesticides PCBs TRPH	To assess the general ground water quality in the suspected landfill area.

DAMES & MOORE - AREA 18 (SMALL POND WITH DRUMS)		
ACTIVITY	**PARAMETER**	**REASON**
UXO Search	Subsurface Ordnance	A UXO search will be conducted to clear the area prior to any invasive activities. If anomalies are detected, no drilling will be performed in the suspect area.
Soil Borings/Sampling	VOCs Semivolatiles Metals Pesticides PCBs TRPH	To assess subsurface soils adjacent to pond with drums in it for potential chemical contamination.
Sediment Sampling	VOCs Semivolatiles Metals Pesticides PCBs TRPH	To assess pond sediments for potential chemical contamination.
Monitoring Well Installation and Ground Water Sampling	VOCs Semivolatiles Metals Pesticides PCBs TRPH	To assess ground water quality in a down gradient vector from the pond with drums in it.

DAMES & MOORE - AREA 18 (SHOPS, WAREHOUSES, UNDEVELOPED)		
ACTIVITY	**PARAMETER**	**REASON**
UXO Search	Subsurface Ordnance	A UXO search will be conducted to clear the area prior to any invasive activities. If anomalies are detected, no drilling will be performed in the suspect area.
OVA Survey - around each warehouse; - in undeveloped areas	Volatile Organic Vapors	To help assess potential presence of organic vapors indicative of subsurface contamination.
Soil Boring/Sampling - adjacent to boreholes with high OVA readings.	VOCs Semivolatiles Metals Pesticides PCBs TRPH	Analyze potential contamination in soils.

DAMES & MOORE - AREA 18 (UNDERGROUND TANKS)		
ACTIVITY	**PARAMETER**	**REASON**
UXO Search	Subsurface Ordnance	A UXO search will be conducted to clear the area prior to any invasive activities. If anomalies are detected, no drilling will be performed in the suspect area.

DAMES & MOORE - AREA 18 (UNDERGROUND TANKS)		
ACTIVITY	**PARAMETER**	**REASON**
Visual Assessment and EM Survey - within 15 feet of building foundations • all guardhouse locations • buildings in dock area • outlying buildings • Southwest of engine rebuild shop - buildings that are reported or suspected to have used storage tanks	Subsurface Anomalies	Small fuel tanks may have been present in these areas, but may not have been shown in drawings. To assess "shop" buildings for signs of presence of storage tanks.
Soil Borings/Sampling - areas of known or suspected fuel oil tanks - Where EM anomalies occur adjacent to buildings	BTEX & TRPH VOCs Semivolatiles Metals Pesticides PCBs	To assess subsurface soil in areas of potential fuel oil or chemical contamination.

5.0 FIELD SET UP

5.1 MOBILIZATION

Two Dames & Moore field teams will be on site during the field investigation at the former Raritan Arsenal. Miscellaneous field supplies will be purchased in Cranford, New Jersey, or Chicago, Illinois, and shipped to the field team's hotel by air. Dames & Moore personnel will travel to Edison, New Jersey, by air and/or car. Miscellaneous site tasks will be performed prior to mobilization of the driller, including orientation to the site, the UBX survey, the soil gas survey, and establishment of needed area facilities including telephone access, water, and sanitary facilities.

5.2 ON-SITE SET UP

Decontamination supplies will be shipped from Chicago and/or purchased in the area prior to the mobilization of the driller to the site. Decontamination supplies will include:

- wash tubs
- brushes
- Alconox® detergent
- buckets
- garbage cans with lids
- garbage bags
- paper towels
- plastic sheeting
- hose
- other items

5.3 SUBCONTRACTOR INFORMATION

The following subcontractors will perform during the Raritan Arsenal site investigation:

UXB International, Inc., Chantilly, Virginia, will provide ordnance-related safety services, including verification that the borehole locations and the access routes to the boreholes do not contain buried ordnance.

Tracer Research Corporation, Tucson, Arizona, will provide manpower and equipment to conduct a soil-gas survey to aid in the location of the monitoring wells and soil borings.

Environmental Science & Engineering, Gainesville, Florida, will provide laboratory analysis of all soil, sediment, and water samples.

Robert B. Harrison, Pennington, New Jersey, will provide surveying services for the new wells to be installed at the site. Surveying of the existing wells is not included in the scope of work.

Laura A. Brinkerhoff, Inc., Brick, New Jersey, will provide drilling services, and well installation and development services.

6.0 SAMPLE NUMBERING SYSTEM

6.1 PROJECT IDENTIFICATION

The project will be identified on all sample labels as United States Army Corps of Engineers, abbreviated USACE, with the assigned Dames & Moore job number for the project. An example of a chemical analysis label is provided in Figure 8.

6.2 SITE IDENTIFICATION

The site shall be identified on all sample labels as "Raritan, Area _(Number or Number-Letter)_."

6.3 BORING, MONITORING WELL, OR AREA NUMBER

Each sample will be labeled with the appropriate boring, monitoring well, or area number. Environmental borings shall be identified by the following: A "B" to signify a soil boring, followed by the area from which it was drilled and sampled, followed by the sequence number of the boring for that area only. Monitoring wells installed by Dames & Moore will be identified as MW-40 through MW-61. Where a monitoring well cluster is installed, the shallow well will be designated with a number and the letter "A"; the deep well will be designated with the same number and the letter "B". Existing wells will be identified consistent with the Contamination Evaluation Report prepared by OBG (MW-1 through MW-37).

6.4 SAMPLE DEPTH

Identification of soil samples will include the depth interval (in feet below the ground surface) from which the sample was taken.

6.5 SAMPLE TYPE (MEDIA)

Soil samples will be labeled with the term "soil," water samples will exhibit the term "water," and sediment samples will be labeled with the term "sediment."

6.6 OTHER INFORMATION

Each sample also will be labeled with the date and time (in 24-hour clock reference) of its acquisition, and the sampler's initials.

6.7 EXAMPLE

Sample labels will contain the following information:

- Client: USACE;
- Dames & Moore Job Number: 19577-006-007;
- Location: [Raritan (Edison, New Jersey) town and state will not be written on all sample labels];
- Borehole Designation;
- Sample Depth;
- Media: soil/water;
- Date;
- Time; and
- Sampler's Initials.

6.8 QUALITY ASSURANCE SAMPLES

Quality assurance sampling will be conducted in accordance with the Chemical Data Acquisition Plan, and will amount to approximately 10 percent of the total sampling effort. Trip blanks will be prepared by the laboratory subcontractor using field sample collection containers and double distilled, deionized water. The trip blanks will accompany the sample bottles through the entire sampling history. This type of blank permits a determination of the laboratory's cleaning procedures of sample containers; these bottles will remain sealed until opened for analysis. Field blanks will be prepared in the field with distilled water rinsed through the decontaminated ISCO sampling system; this type of blank serves as a check on the field cleaning procedures.

Trip blanks and field blanks will be identified using the same numbering system as for standard samples to ensure that no preferential treatment is given to quality assurance samples. In general, quality assurance samples will be labeled as such only in the Dames & Moore field logs, and will be identified similar to their corresponding sample.

Field duplicate soil and water sampling also will be conducted for quality control purposes. Duplicate water samples will be collected by sequentially filling two sample bottles with water from a single sample collection. All duplicate water samples will receive identical treatment, and will be identified using the same numbering system established for standard samples.

CLP laboratory procedures will be followed during analysis. However, CLP documentation will not be provided. Detailed quality assurance information for the Raritan project is presented in another Dames & Moore document titled, "Chemical Data Acquisition Plan, for U.S. Army Corps. of Engineers Investigation of the Former Raritan Arsenal, Edison, New Jersey," dated October, 1991.

7.0 DECONTAMINATION PROCEDURES

7.1 GEOTECHNICAL INVESTIGATION

Precautions will be taken not to transfer potential contamination from one boring location to another. The rear end of the drill rig, augers, rods, samplers, and all other equipment utilized while drilling will be steam-cleaned before drilling at each boring location.

7.2 DRILLING, SOIL SAMPLING, AND MONITORING WELL INSTALLATION

Split-spoon samplers and soil sampling tools used to obtain geotechnical samples will be decontaminated after each sampling effort according to the following procedure:

1. Scrub majority of soil off using potable water;
2. Wash with a mixture of potable water and Alconox® detergent; and
3. Rinse three times with distilled water.

Split-spoon samplers and other soil and water sampling tools used to obtain samples for chemical analysis will be decontaminated after each sampling effort according to the following procedure:

1. Wash with Alconox® detergent, rinse with potable water; and
2. Rinse three times with distilled water; the final rinse requires the use of reagent-grade water.

The decontamination zone for the split-spoon samplers and the other soil and water sampling tools will be established near each borehole. The decontamination area will consist of a low-lying area covered with a 6-mil polyethylene sheet. At the completion of decontamination procedures at each of the borings, the debris will be enclosed in the sheet and deposited into 55-gallon type 17 E/H drums for later disposal. The decontamination zone for the rear end of the drill rig, augers, rods, and other large items of equipment used during drilling and sampling will be established adjacent to each sampling area. A low-lying area will be covered with a 6-mil polyethylene sheet to collect the water and solid wastes generated during steam cleaning of the equipment; the debris will be deposited into 55-gallon-type 17 E/H drums for later disposal. The water/soils generated during the decontamination of equipment will be disposed as stated in Section 13.0.

7.3 WELL DEVELOPMENT

Wells will be developed by bailing or pumping. Any part of the development equipment that is placed in the well will be decontaminated using the following procedure:

1. Wash with Alconox® detergent, rinse with potable water; and
2. Rinse two times with distilled water; the final rinse requires the use of reagent-grade water.

7.4 WATER LEVEL MEASUREMENT

The probe used for water level measurements will be decontaminated between wells using the decontamination procedure described in Section 7.2 for geotechnical samples.

7.5 WATER SAMPLING

Water samples will be obtained by the use of an ISCO non-dedicated sampling system, as described in Section 3.2.5. The bladder will be decontaminated as stated in Section 7.2 for chemical analysis samples. New suction and discharge tubing will be used for each well.

7.6 PERSONNEL DECONTAMINATION

Persons working on the site shall undergo decontamination before leaving the site. In most instances, removal of protective clothing will suffice for decontamination. Facilities for storage of reusable protective clothing and for the disposal of clothing contaminated beyond reuse will be constructed or placed on site. Also, facilities for decontaminating hands, boots, and gloves, consisting of a detergent wash and water rinse, will be provided.

7.7 SAMPLE HANDLING

Samples will be handled by personnel wearing nitrile gloves to avoid contamination. The sample containers will be well-cushioned with packing materials when they are placed in the insulated cooling chests for transportation to the laboratories. Care will be taken to seal bottle caps tightly. Extra insurance against opening in transit will be provided by sealing the caps with filament tape for medium concentration samples; however, tape will not be used on VOC vials. The bottles then will be placed in self-sealing plastic bags. Further information on sample handling is presented in Section 10.0.

8.0 CALIBRATION OF FIELD EQUIPMENT

All field equipment will be calibrated according to the manufacturers' specifications, and as described below. The personnel assigned to take measurements in the field will assemble as much equipment as feasible in the laboratory prior to mobilization to the site. The personnel will become familiar with the calibration of all instruments, as outlined in the respective manuals, and will make all calibrations that can be made at that time. Pertinent sections of the respective manuals will be photocopied for reference in the field, and all equipment that will be necessary for field calibration, such as buffer solutions and calibration gases, will be assembled for mobilization to the site.

LIST OF FIELD EQUIPMENT

7.1	Total Organic Vapor Analyzer - Photoionization Detector
7.2	Conductivity Meter
7.3	pH Meter
7.4	Thermometer
7.5	ISCO Series 3600 Well Sampling System
7.6	Decontamination Supplies
7.7	Respirators, Cartridges, and Filters
7.8	Locks
7.9	Electronic Water Level Indicator
7.10	Soil Sampling Equipment

8.1 TOTAL ORGANIC VAPOR ANALYZER

The analyzer used will be a photoionization detector. This a quantitative instrument that measures the total concentration of numerous organic vapors in the air. The instrument is used primarily as a safety or screening device to determine the presence and concentration of organic vapors. It is battery operated and lightweight, making it very useful in actual field monitoring projects. The instrument is calibrated by introducing pressurized gas from a cylinder with a known organic concentration into the detector. Once the reading has stabilized, the display of the instrument is adjusted to match the known concentration. A calibration of this type is performed each day prior to using the instrument. If the output differs greatly from the known concentration, the initial procedure to remedy the problem is a thorough cleaning of the instrument. The cleaning process normally removes foreign materials that affect the calibration of the instrument. If this procedure does not remedy the problem, further troubleshooting is performed until the problem is resolved. If the problem cannot be resolved by Dames & Moore technicians, the instrument is returned to the manufacturer for repair. A working meter will be shipped to the site immediately if problems occur. The manufacturer's manual will accompany the meter.

8.2 CONDUCTIVITY METER

The conductivity meter used will be a Cole Palmer Model 1491-61 DIST 2 ATC Dissolved Solid Tester. The DIST 2 ATC has a detection range from 20 parts per million (ppm)

to 10,000 ppm, and has automatic temperature compensation. The meter is calibrated to a ppm standard solution that is similar in composition to the solution to be measured in the field. The detector is immersed in the standard solution until the display reads the appropriate factored value of the calibration standard solution. The meter will be calibrated before use in the field. Calibrating standard solution shall be taken to the field for field calibration purposes.

8.3 pH METER

The pH meter used will be a Cole Palmer Model 5941-00-pHep-pH meter. The meter is simple to use and has a digital pH display. To calibrate, the meter is immersed in a calibrating solution with a known pH, preferably a pH 7 solution. Calibration is repeated periodically. The electrode is cleaned by rinsing with distilled water after each use.

8.4 THERMOMETER

The thermometer used will be a Cole Palmer Model. The meter is simple to use and has a digital display. Calibration and other information is provided in the operators manual which will accompany the thermometer to the site.

8.5 ISCO SERIES 3600 WELL SAMPLING SYSTEM

The batteries for the controller will be recharged each night. The unit will be visually inspected daily to ensure that connections have not loosened and the pump has not been damaged. Sufficient quantities of the gas/oil mixture for the compressor motor will be available to accomplish a full day's sampling.

8.6 DECONTAMINATION SUPPLIES

All sampling equipment will be decontaminated prior to use and between samples to avoid cross-contamination. Decontamination supplies will include Alconox® detergent and distilled water, in accordance with procedures suggested by the USACE. Other supplies will include buckets, tubs, and brushes. Alconox® laboratory-grade detergent (Fischer Scientific Company) will be used due to its sudsing and low residue properties. The final rinsing of equipment used to obtain samples for chemical analysis will be done using laboratory-grade distilled deionized water. All decontamination supplies will be transported sealed in unbreakable

containers. The containers will be inspected visually for leaks or contamination prior to each use.

8.7 RESPIRATORS, CARTRIDGES, AND FILTERS

Combination filter/cartridge respirators will be donned by sampling personnel if field situations warrant. The respirators will be fitted with GMA cartridges with Type F filters for removal of organic vapors, dusts, and mists. These are NIOSH (National Institute for Occupational Safety and Health)-tested, and NIOSH- and MSHA (Mine Safety and Health Administration)-approved. The GMA cartridge is approved for use in atmospheres containing at least 19.5 percent oxygen and less than 0.1 percent organic vapors by volume.

8.8 LOCKS

Good quality, reasonably priced padlocks will be placed on each monitoring well to discourage tampering and vandalism. The locks will be purchased from a locksmith supplier or hardware store and will be performance tested at the time of purchase and when placed on a well. To the extent practical, the locks will be keyed alike to avoid the possibility of confusion among keys.

8.9 ELECTRONIC WATER LEVEL INDICATOR

The type of water level indicator used will be a Soil Test, 100-foot electronic water level indicator. Each indicator is calibrated against National Bureau of Standards traceable instrumentation. Field calibration will entail measurement between wire marks with an accurate tape measure to help ensure length validity.

8.10 SOIL SAMPLING EQUIPMENT

Soil sampling equipment will be limited to the use of split spoon samplers, as described in Section 3.1.2.1, stainless steel trowels, and stainless steel sampling knives.

9.0 PREVENTIVE MAINTENANCE OF FIELD EQUIPMENT

All field equipment will be maintained according to manufacturers' specifications, as discussed below. All equipment will be assembled in the laboratory, if feasible, for calibration prior to mobilization; at this time, the equipment will be checked to ensure that it is in proper working order, and any required maintenance will be performed. Tools and equipment that may be needed for field maintenance will be assembled, and pertinent sections of the manuals will be photocopied for reference in the field.

List of Field Equipment Requiring Preventive Maintenance

8.1	Total Organic Vapor Analyzer
8.2	Conductivity Meter
8.3	pH Meter
8.4	Thermometer
8.5	ISCO Series 3600 Well Sampling System
8.6	Electronic Water Level Indicator

9.1 TOTAL ORGANIC VAPOR ANALYZER

The detector must be kept clean for accurate operation. Foreign materials can be rinsed or wiped off or blown out of the detector. The cord between the analyzer and the recorder should not be wound tightly, and will be inspected visually for integrity before going into the field. A new cord will be ordered from the manufacturer if problems are found. A battery check indicator is included on the equipment and will be checked prior to going into the field and prior to use. The batteries will be charged if found to be weak. The analyzer, probe, and meter will be packed securely and handled so as to minimize the chance of damaging parts.

9.2 CONDUCTIVITY METER

The conductivity meter will be transported in a protective case. The cell will be tested before going into the field. The detector must be kept clean, and will be rinsed with distilled water rinses after each use.

9.3 pH METER

The probe and meter will be packed in a protective case for transport. The electrode must be kept clean, and will be cleaned with distilled water rinses after each use.

9.4 THERMOMETER

The thermometer will be kept clean and stored in a protective case. It will be cleaned with distilled water rinses after each use.

9.5 ISCO SERIES 3600 WELL SAMPLING SYSTEM

The sampling system will be inspected visually to ensure that connections and fittings are not stripped. The operation of the system will be tested before going into the field and cleaned, repaired, or replaced, as necessary. New suction and discharge tubing will be used at each well.

9.6 ELECTRONIC WATER LEVEL INDICATOR

New batteries will be installed prior to entering the field. Extra batteries will be made available in the field.

10.0 ENVIRONMENTAL SAMPLE HANDLING AND PACKAGING

10.1 SPLIT SAMPLE PROCEDURES

In order for split sample analysis to be valid, the split sample must be as homogeneous as possible. Split-spoon samples will be split vertically so that vertical stratification of contaminants will be distributed equally between the samples. Half of the sample (one of the split sides) will be transferred to the regular sample container; the duplicate half will be transferred to the similarly labeled duplicate or split sample container. Stainless steel sampling spoons and knives will be used.

Split ground water samples will be collected at the same time by sequentially filling sample jars. Sample containers, preservatives, and handling will be identical for each member of the split sample. Duplicate samples will be gathered in a similar manner.

10.2 SAMPLE CONTAINERS

Sample containers will be provided by the analytical laboratory. The containers will be either plastic or glass with Teflon®-lined lids and will be pretreated with preservatives as applicable. CLP laboratory specifications will be followed; however, CLP documentation will not be provided.

10.3 SAMPLE HANDLING AND DECONTAMINATION

After sample collection in the field, sample containers will be decontaminated if gross contamination is present. The sample containers will be handled with gloves until decontaminated with a detergent wash and water rinse if spills have occurred on the outside of the container. Care must be taken to avoid damaging the label during decontamination. The samples will be stored on ice in insulated containers and will be shipped via overnight carrier to the laboratory at the end of each day's sampling.

10.4 PROCEDURES FOR PACKING AND SHIPPING LOW CONCENTRATION SAMPLES

Packing procedures will follow recommendations given in the USACE Regulation No. ER1110-1-263 "Engineering and Design, Chemical Data Quality Management for Hazardous Waste Remedial Activities" (March 1, 1989), as described for environmental samples without gross signs of contamination. These samples will be packaged as follows:

- Use water-proof metal (or equivalent strength plastic) ice chests or coolers only.
- After filling out the pertinent information on the sample label and tag, put the sample in the bottle or vial and screw on the lid. For bottles other than VOA vials, secure the lid with strapping tape (tape on VOA vials may cause contamination). Then, secure the string from the numbered approved tag around the lid.
- Mark volume level on bottle with grease pencil. VOA vials will be completely filled to eliminate head space, and will not be marked with a grease pencil.

- Place about 3 inches of inert cushioning material such as vermiculite in the bottom of the cooler.

- Enclose the bottles in clear plastic bags through which sample tags and labels are visible, and seal the bag. Place bottles upright in the cooler in such a way that they do not touch and will not touch during shipment.

- Put in additional inert packing material to partially cover sample bottles (more than halfway). Place bubble wrap or packing material around, among, and on top of the sample bottles.

- Add sufficient ice (double bagged) to keep the samples cool (4° C, maximum) until received by the analytical laboratory.

- Fill cooler with cushioning material.

- Put paperwork (chain of custody record) in a waterproof plastic bag and tape it with masking tape to the inside lid of the cooler.

- Tape the drain shut.

- Secure lid by taping, wrapping the cooler completely with strapping tape at a minimum of two locations. Do not cover any labels.

- Attach completed shipping label to top of the cooler.

- Put "This Side Up" labels on all four sides and "Fragile" labels on at least two sides.

- Affix numbered and signed custody seals on front, right, and back left of cooler. Cover seals with wide, clear tape.

10.5 PROCEDURE FOR PACKING MEDIUM CONCENTRATION SAMPLES

Medium concentration samples will be packed in the same manner as described in Section 9.4 for low concentration samples. However, an effort will be made to identify, by visual examination in the field, any samples suspected of having elevated contaminant concentrations. These samples will be segregated and packed in a separate container to the extent allowed by prevailing field conditions. Containers for these samples will be sealed with tape in addition to the normal processing used on all samples collected.

10.6 PROCEDURE FOR PACKING GROUND WATER, SURFACE WATER, AND SEDIMENT SAMPLES FROM AREA 5

Because of the potential presence of mustard gas decomposition products in the ground water, surface water, and sediment samples from this area, these samples will be packed as shown above for medium concentration samples. The VOA vials will not be sealed with tape, but will be double-wrapped in self-sealing plastic bags. The samples will be shipped in a separate cooler. An appropriate warning will be securely taped to the outer portion of the cooler, directing the recipient to refer to the chain-of-custody prior to opening any sample containers. The chain-of-custody will clearly indicate the potential presence of mustard gas decomposition products.

Additionally, the ESE laboratory will be advised, by telephone, of the shipping date for the cooler, and will be given a description of the cooler.

11.0 ENVIRONMENTAL SAMPLE CUSTODY AND DOCUMENTATION

11.1 SAMPLE IDENTIFICATION DOCUMENTS

Each sample will be identified using the sample numbering system described in Section 6. A label on each sample container will contain the following information:

- Client: USACE;
- Dames & Moore Job No.: 19577-006-007;
- Location: Raritan;

10.5 PROCEDURE FOR PACKING MEDIUM CONCENTRATION SAMPLES

Medium concentration samples will be packed in the same manner as described in Section 9.4 for low concentration samples. However, an effort will be made to identify, by visual examination in the field, any samples suspected of having elevated contaminant concentrations. These samples will be segregated and packed in a separate container to the extent allowed by prevailing field conditions. Containers for these samples will be sealed with tape in addition to the normal processing used on all samples collected.

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Additionally, the ESE laboratory will be advised, by telephone, of the shipping date for the cooler, and will be given a description of the cooler.

11.0 ENVIRONMENTAL SAMPLE CUSTODY AND DOCUMENTATION

11.1 SAMPLE IDENTIFICATION DOCUMENTS

Each sample will be identified using the sample numbering system described in Section 6. A label on each sample container will contain the following information:

- Client: USACE;
- Dames & Moore Job No.: 19577-006-007;
- Location: Raritan;

- Borehole Designation;
- Sample Depth;
- Media;
- Date;
- Time; and
- Sampler's Initials.

11.2 CHAIN-OF-CUSTODY RECORDS

A sample chain-of-custody form to be used during this investigation is illustrated in Figure 12. Chain-of-custody procedures will be followed so that the possession of a sample can be traced from the time of collection until the data are used in legal proceedings. One or more chain-of-custody forms will accompany each set of samples shipped from the site. Each time the custody of the samples is transferred, the form will be signed by both the person relinquishing and the person receiving the samples. A copy of the form will be retained by the sampler, who will fill in the information on sample identity and who will also be the first person to relinquish the sample. If the sample containers appear to have been opened or tampered with, this should be noted by the person receiving the samples under the section entitled "Remarks."

11.3 FIELD LOG BOOKS

Each Dames & Moore Field Team member will maintain a personal field log book while on the site. Information recorded in the log book will be written in an objective, factual manner so that persons reading the entries will be able to determine the sequence of events as they occurred in the field. If notes are made in the log book by someone other than the owner of the book, this will be indicated by the writer's signature and date. Information that may be recorded in the field log book include:

- Date and time of entry;
- Sample number;
- Sample description;
- Method of sampling;
- Location of sampling;
- Sketch of sample location;

- Field measurements such as pH, conductivity, temperature, and water level;
- Names and phone numbers of field contacts, drillers, and persons on-site;
- Materials used in well construction;
- Driller's standby and drilling time; and
- Weather and field conditions during drilling and sampling.

In addition to the above information, the following forms will be used to record detailed data:

- HTW Boring Log (Figure 4) - used in the field to record detailed sample descriptions and drilling methods;

- Field Memorandum (Figure 13) - used to outline daily activities for information of project manager and file records; and

- Monitor Well Detail Information Sheet (Figure 10) - used to record details of well installation.

- Stabilization Test (Figure 11) - used to stabilize the wells prior to sampling.

11.4 CORRECTIONS TO DOCUMENTATION

Any errors or mistakes in the original field data will be crossed out with a single line, and the person making the correction will initial it. No data will be erased.

In some circumstances, original documents may be transcribed, making appropriate changes and eliminating errors. In these cases, the successive documents will be dated and numbered as sequential drafts.

11.5 SAMPLE TRAFFIC REPORTS

Knowledge of sample status will be maintained through review and evaluation of Dames & Moore Field Engineer/Geologist reports, discussions with field personnel, and through contact with the analytical laboratory on a periodic basis. In this way, a working knowledge of sample traffic will be available through the project.

11.6 SHIPPING OF SAMPLES

Samples will be shipped at the end of each day's sampling efforts. Sample containers will be shipped via an overnight carrier.

12.0 CHEMICAL ANALYSIS

As outlined in the scope of work provided by USACE, chemical analysis may include the following parameters:

1. A search for volatile and semi-volatile organics as listed in Table 2 of USEPA Methods 8240 and 8270, respectively.

2. Analyses for metals, cyanide, and explosives.

   - Analyses for total metals: arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver. Analyses shall be by methods in Table 2 of Appendix C of ER 1110-1-263 (dated March 1989).

   - Analyses for cyanide: analysis of water samples shall be by method 9012 (certified reporting limit = 2.5 ppb or μg/l), and analysis of soil shall be by method 9010 (reporting limit = 0.92 μg/g or ppm).

- Analyses for explosive compounds:

LW12
NITROAROMATICS IN SOIL BY HPLC

		Control Limits								
					MAA			ACCU		
SHORT NAME	LONG NAME	CRL	UCR	SLOPE	LCL	UCL	MAP	LCL	UCL	PREC
135TNB	+1,3,5-trinitrobenzene	0.488	24.4	0.991	74.7	91.2	25.0	90.6	99.6	7.8
13DNB	1,3-dinitrobenzene	0.496	24.8	0.952						
246TNT	2,4,6-trinitrotoluene	0.456	22.8	1.01						
24DNT	+2,4-dinitrotoluene	0.424	21.2	0.938	84.1	105.7	21.7	76.9	88.1	9.8
26DNT	2,6-dinitrotoluene	0.524	26.2	0.977						
HMX	Cyclotetramethylene Tetranitramine	0.666	33.3	1.000						
NB	+Nitrobenzene	2.41	27.4	0.793	68.9	95.9	27.1	69.7	82.5	11.1
NG	+Nitroblycerin	4.00	200.0	0.931	64.8	119.0	54.3	74.1	87.3	11.4
PETN	+PETN	4.00	80.0	0.969	72.2	105.0	41.2	77.2	88.8	10.1
RDX	+Cyclonite	0.587	21.9	0.929	67.2	101.8	43.5	71.5	82.5	9.5
TETRYL	Nitramine	0.731	20.2	1.130						

+ These compounds are the control spikes for this method.

Note: All control limits are subject to change as per the Usathama QA plan control chart protocol.

CRL	Certified Reporting Limit (microgram per gram)
UCR	Upper Certified Range (micrograms per gram)
SLOPE	Represents average accuracy over the certified range
MAA	Moving Average Accuracy (percent recovery)
LCL	Lower Control Limit of the Accuracy
UCL	Upper Control Limit of the Accuracy
MAP	Moving Average Precision
PREC	Precision of the Replicate High Spike
ACCU	Accuracy of the Replicate High Spike

UW14
NITROAROMATICS IN WATER BY HPLC

		Control Limits								
					MAA			ACCU		
SHORT NAME	LONG NAME	CRL	UCR	SLOPE	LCL	UCL	MAP	LCL	UCL	PREC
HMX	Cyclotetramethylene Tetranitramine	1.65	28.9	0.932						
RDX	+Cyclonite	2.11	43.9	0.851	74.2	110.2	45.3	80.8	113.6	28.4
135TNB	+1,3,5-trinitrobenzene	0.626	42.1	0.817	60.4	93.4	41.5	70.6	92.4	18.9
13DNB	1,3-dinitrobenzene	0.519	40.1	0.832						
NB	+Nitrobenzene	1.07	54.9	0.795	63.3	98.5	44.3	66.8	97.7	26.8
TETRYL	Nitramine	0.556	44.5	0.749						
246TNT	2,4,6-trinitrotoluene	0.588	40.2	0.855	57.5	99.3	52.5	74.4	97.4	19.9
26DNT	2,6-dinitrotoluene	1.15	52.4	0.767						
24DNT	+2,4-dinitriroluene	0.612	40.2	0.835	67.8	96.0	35.5	71.8	96.6	21.6

Note: All control limits are subject to change as per the Usathama QA plan control chart protocol.

+ These compounds are the control spikes for this method.

CRL Certified Reporting Limit (microgram per gram)
UCR Upper Certified Range (micrograms per gram)
MAA Moving Average Accuracy (percent recovery)
LCL Lower Control Limit of the Accuracy
UCL Upper Control Limit of the Accuracy
MAP Moving Average Precision
PREC Precision of the Replicate High Spike
ACCU Accuracy of the Replicate High Spike

3. Identification and quantification of 10 volatile organics not appearing in Table 2 of USEPA Method 8240.

4. Identification and quantification of 20 semivolatile organics not appearing in Table 2 of USEPA Method 8270.

5. Analyses for pesticides and PCBs shall be conducted by method 8080 found in Table 2 of Appendix C of ER 1110-1-263 (dated March 1989).

6. Analysis for Organo-Sulfur compounds shall be conducted by USATHAMA method LL-03 (soil), and by USATHAMA method UL04 (water).

7. Analysis for Thiodiglycol shall be conducted by USATHAMA method LW-18 (soil), and by USATHAMA method UW22 (water).

13.0 SITE CLEANUP

A certain amount of trash will be generated from site investigation activities, including protective clothing, gloves, and cement bags. This material, assuming it has not been contaminated, will be disposed properly in the municipal sanitary landfill. The site will be policed after completion of activities to help ensure that no trash remains.

A New Jersey DEP guidance memorandum indicates the disposal of materials generated during site investigations are based on the following rationale:

- The materials generated are intrinsic elements of the site and should not be separated from the site; and

- Investigations should not contribute to further environmental degradation, nor should a threat to public health or safety be presented.

Accordingly, in areas where contamination is suspected based on historical information, field testing, or visual observations, drill cuttings development, water etc. may be disposed on site if:

- The surface soils in area(s) of disposal are known or suspected to be contaminated above soil action levels;

- The disposed material will not migrate onto uncontaminated areas;

- There is no potential to contaminate an uncontaminated aquifer; and

- There is no potential to create a health hazard to adjoining property owners through the airborne exposure route.

In areas which are not suspected of containing contamination, the materials may be disposed on site if:

- The soil or water will not erode or flow off site; and
- Disposed water will not flow through an area of contamination and spread the contamination to a clean area.

Disposition of the development water, well stabilization water, and decontamination water generally will be accomplished by pouring the water on the ground in a controlled manner to prevent runoff. This procedure would not be followed in Area 1, Area 2, Area 3, Area 6, or Area 9; although ground water contamination was found by OBG in these areas, the contaminants were not detected above NJDEP action levels in the surface soils. Fluids generated in these areas will be drummed pending analysis of the well water. If the analysis indicate the well water contains no contaminants above action levels, it will be disposed on site. If contamination above action levels is present, discussions will be held with USACE personnel to establish a method of disposal; disposal of these fluids is the responsibility of USACE.

Generally, soil cuttings will be returned to the borehole unless the boring extends to the depth of the ground water. If the borings advanced for soil sampling extend to the depth of the ground water, the borehole will be grouted, as shown in Section 3.1.3. The soil cuttings will be disposed on site by spreading them over the ground surface, taking care that the disposed soil will not erode onto adjacent areas. In Area 1, Area 2, Area 3, Area 6 and Area 9, the soil cuttings generated during the installation of monitoring wells will be drummed pending the receipt of analytical data from the monitoring well. If the analyses indicate the well water contains no contaminants above action levels, the cuttings will be disposed on site. If contamination above action levels is present, discussions will be held with USACE personnel to establish a method of disposal; disposal of these cuttings is the responsibility of the USACE.

All drums will be approved Department of Transportation design with removable sealing lids, type 17 E/H.

14.0 FIELD TEAM ORGANIZATION AND RESPONSIBILITIES

14.1 ORGANIZATION

The Dames & Moore project organization for the former Raritan Arsenal Investigation will be as follows:

- Project Director: Mr. James R. Boddy, Associate
- Project Manager: Mr. William F. Klaassens, Associate
- Field Manager/Site Safety Officer: to be determined
- Principal Investigator: Mr. Michael Rehor, Staff Engineer

A number of additional Dames & Moore staff level personnel will assist in field operations, data interpretation, and report preparation, as necessary.

14.2 RESPONSIBILITIES

Responsibilities for the individuals identified in Section 14.1 will be as follows:

- Project Director -- Responsible for overall project direction and surveillance.

- Principal Manager -- The primary point of contact with COE and Dames & Moore personnel, and the principal senior investigator responsible for project technical activities.

- Principal Investigator -- Assistant to Project Manager in project management and a secondary point of contact with COE. Responsible for technical oversight of all project chemistry activities during data collection.

- Field Manager/Site Safety Officer -- Responsible for organization and direction of field investigations. Will mobilize the field team, to include Dames & Moore assistant professionals or technicians and drilling and surveying subcontractors. Will stake locations of all sampling points and boring locations in consultation with the Project Director and Project Manager, review the site safety plan with site personnel, and monitor the drilling and other site investigation activities. In

addition, will be responsible for proper recording and transmittal of field records, and shipment of samples to the analytical laboratory for analysis.

14.3 TRAINING

The Dames & Moore personnel of staff level and above to be utilized on this project have academic degrees in relevant fields, and previous experience in similar types of investigations. All field personnel will be briefed thoroughly on the appropriate safety measures specific to work on this project, and will have received safety training in accordance with Dames & Moore's firmwide Health and Safety Program.

All site subcontractors will be briefed thoroughly on the following key aspects of project work:

- Project scope of work pertaining to the subcontractor's anticipated role;
- Site Health and Safety Considerations; and
- Timetable, cost, and other limitations pertinent to successful completion of the project within contractual scope.

The subcontractors selected are experienced in related types of investigation, and have a demonstrated technical ability to complete their designated tasks.

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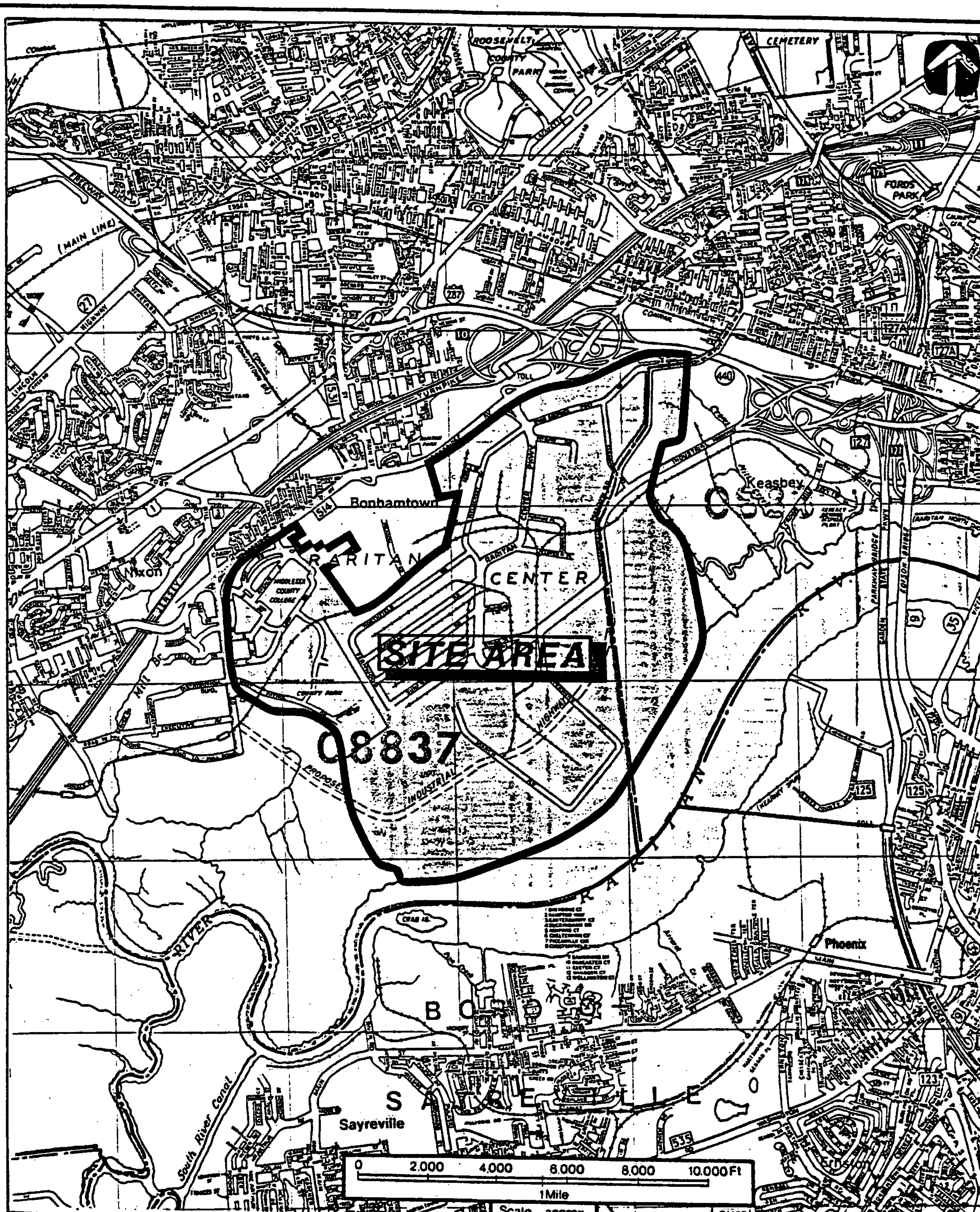


FIGURE 1
SITE LOCATION MAP

SOURCE: Taken from Hagstrom Map: Middlesex County, New Jersey: 1990

DAMES & MOORE
FORMER RARITAN ARSENAL
EDISON, NEW JERSEY
FOR
U.S. ARMY CORPS OF ENGINEERS

HTW DRILLING LOG

HOLE NO.

1. COMPANY NAME	2. DRILLING SUBCONTRACTOR	SHEET 1 OF SHEETS
3. PROJECT	4. LOCATION	
5. NAME OF DRILLER	6. MANUFACTURER'S DESIGNATION OF DRILL	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	8. HOLE LOCATION	
	9. SURFACE ELEVATION	
	10. DATE STARTED	11. DATE COMPLETED
12. OVERBURDEN THICKNESS	15. DEPTH GROUNDWATER ENCOUNTERED	
13. DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %

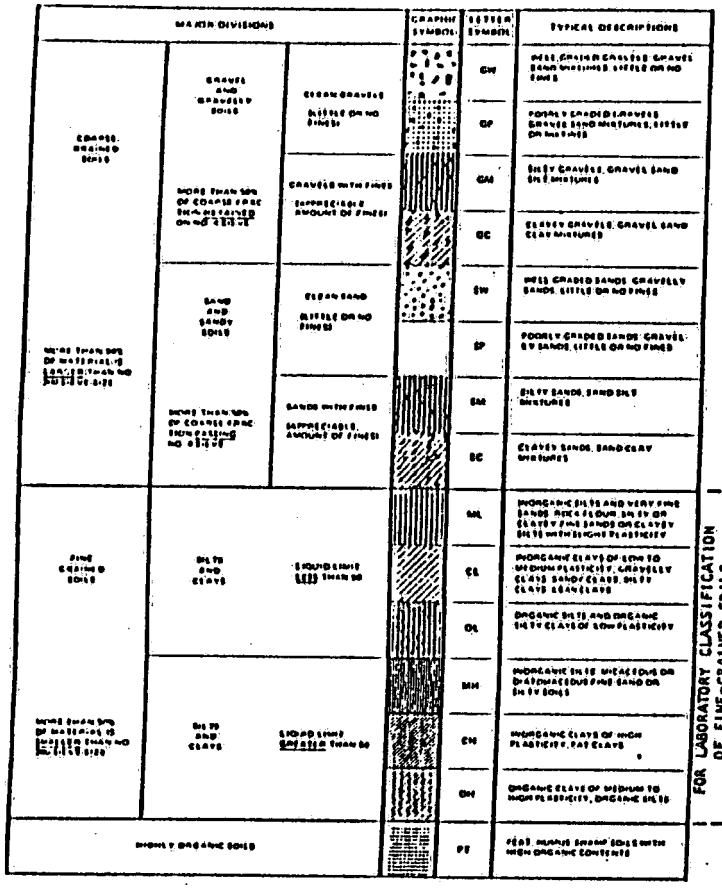
22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h

HTW DRILLING LOG

PROJECT	INSPECTOR	HOLE NO.
		SHEET OF SHEETS

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h

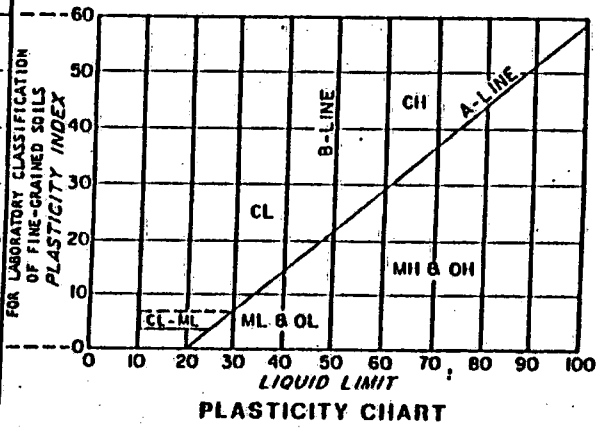


SOIL CLASSIFICATION CHART

MATERIAL SIZE	PARTICLE SIZE			
	LOWER LIMIT		UPPER LIMIT	
	MILLIMETERS	SIEVE SIZE*	MILLIMETERS	SIEVE SIZE*
SAND				
FINE	.074	#200*	0.42	#40*
MEDIUM	0.42	#40*	2.00	#10*
COARSE	2.00	#10*	4.76	#4*
GRAVEL				
FINE	4.76	#4*	19.1	3/4"*
COARSE	19.1	3/4"*	76.2	3"*
COBBLES	76.2	3"*	304.8	12"
BOULDERS	304.8	12"	914.4	36"

*U.S. STANDARD *CLEAR SQUARE OPENINGS

GRADATION CHART



PLASTICITY CHART

KEY TO SAMPLES:

9 ■ THE NUMBER OF BLOWS REQUIRED TO DRIVE THE 3.25" O.D. BY 2.42" I.D. DAMES & MOORE TYPE U SAMPLER 12" OR LENGTH INDICATED WITH A 330 POUND HAMMER FALLING 30".

■ DEPTH OF RELATIVELY UNDISTURBED SAMPLE OBTAINED WITH THE DAMES & MOORE SAMPLER.

▨ DEPTH OF DISTURBED SAMPLE OBTAINED WITH THE DAMES & MOORE SAMPLER.

□ DEPTH OF SAMPLING ATTEMPT WITH NO RECOVERY USING THE DAMES & MOORE SAMPLER.

15 ▯ THE NUMBER OF BLOWS REQUIRED TO DRIVE THE 2.0" O.D. BY 1.4" I.D. STANDARD SPLIT SPOON SAMPLER 12" OR LENGTH INDICATED WITH A 140 POUND HAMMER FALLING 30".

▯ DEPTH OF DISTURBED SAMPLE OBTAINED WITH THE SPLIT SPOON SAMPLER.

▯ DEPTH OF SAMPLING ATTEMPT WITH NO RECOVERY USING THE SPLIT SPOON SAMPLER.

NOTES: 1. DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE CLASSIFICATIONS OR INTERMIXED STRATA.

2. WHEN USED ON THE BORING LOGS, THE FOLLOWING TERMS ARE USED TO DESCRIBE THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE COMPACTNESS OF COHESIONLESS SOILS:

COHESIVE SOILS (APPROXIMATE SHEARING STRENGTH IN KSF)		COHESIONLESS SOILS	
VERY SOFT	LESS THAN 0.25	VERY LOOSE	THESE ARE USUALLY
SOFT	0.25 TO 0.5	LOOSE	BASED ON AN EXAMINATION
MEDIUM STIFF	0.5 TO 1.0	MEDIUM DENSE	OF SOIL SAMPLES,
STIFF	1.0 TO 2.0	DENSE	PENETRATION RESISTANCE,
VERY STIFF	2.0 TO 4.0	VERY DENSE	AND SOIL DENSITY DATA
HARD	GREATER THAN 4.0		

3. WHEN USED ON THE BORING LOGS, THE FOLLOWING TERMS INDICATE THE PERCENTAGES OF THE MINOR SOIL COMPONENTS: SOME: 10 TO 20% TRACE: 0 TO 10%

4. ELEVATIONS REFER TO MEAN SEA LEVEL (MSL).

FIGURE 5
UNIFIED SOIL CLASSIFICATION SYSTEM AND KEY TO LOG BORINGS

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EDISON, NEW JERSEY
FOR
U.S. ARMY CORPS OF ENGINEERS

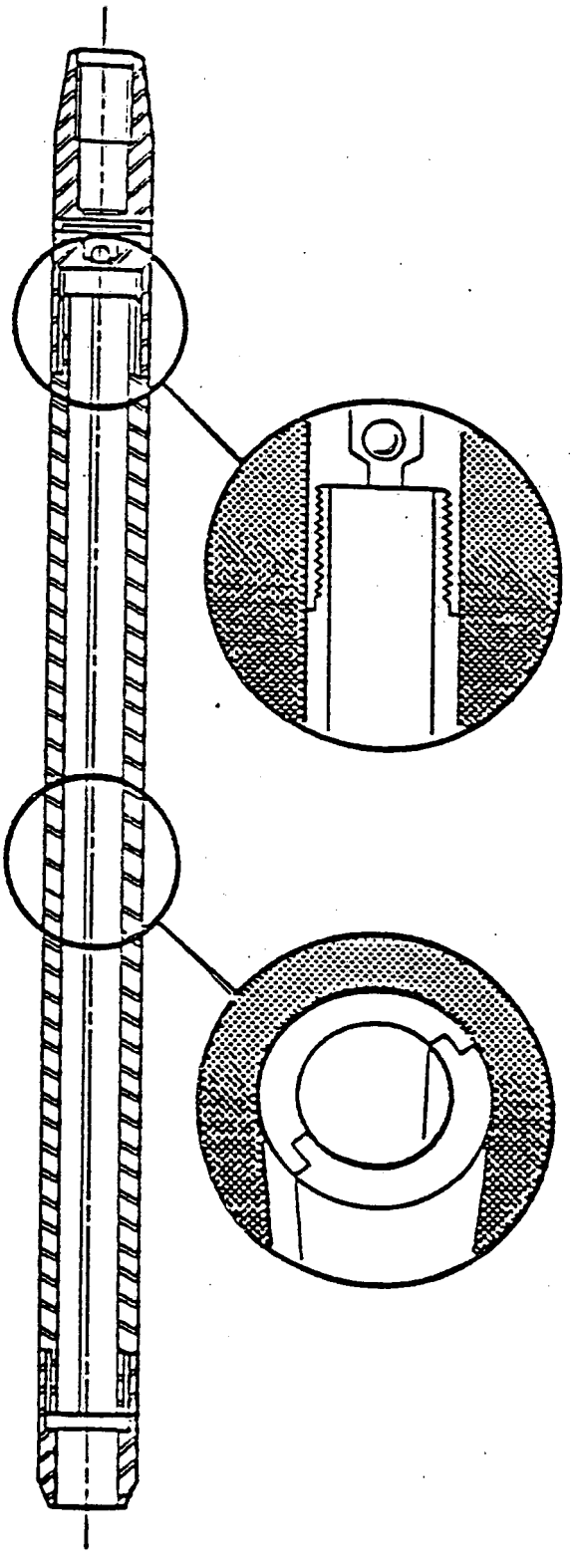


FIGURE 6
SPLIT-SPOON SAMPLER

DAMES & MOORE
FORMER RARITAN ARSENAL
EDISON, NEW JERSEY
FOR
U.S. ARMY CORPS OF ENGINEERS

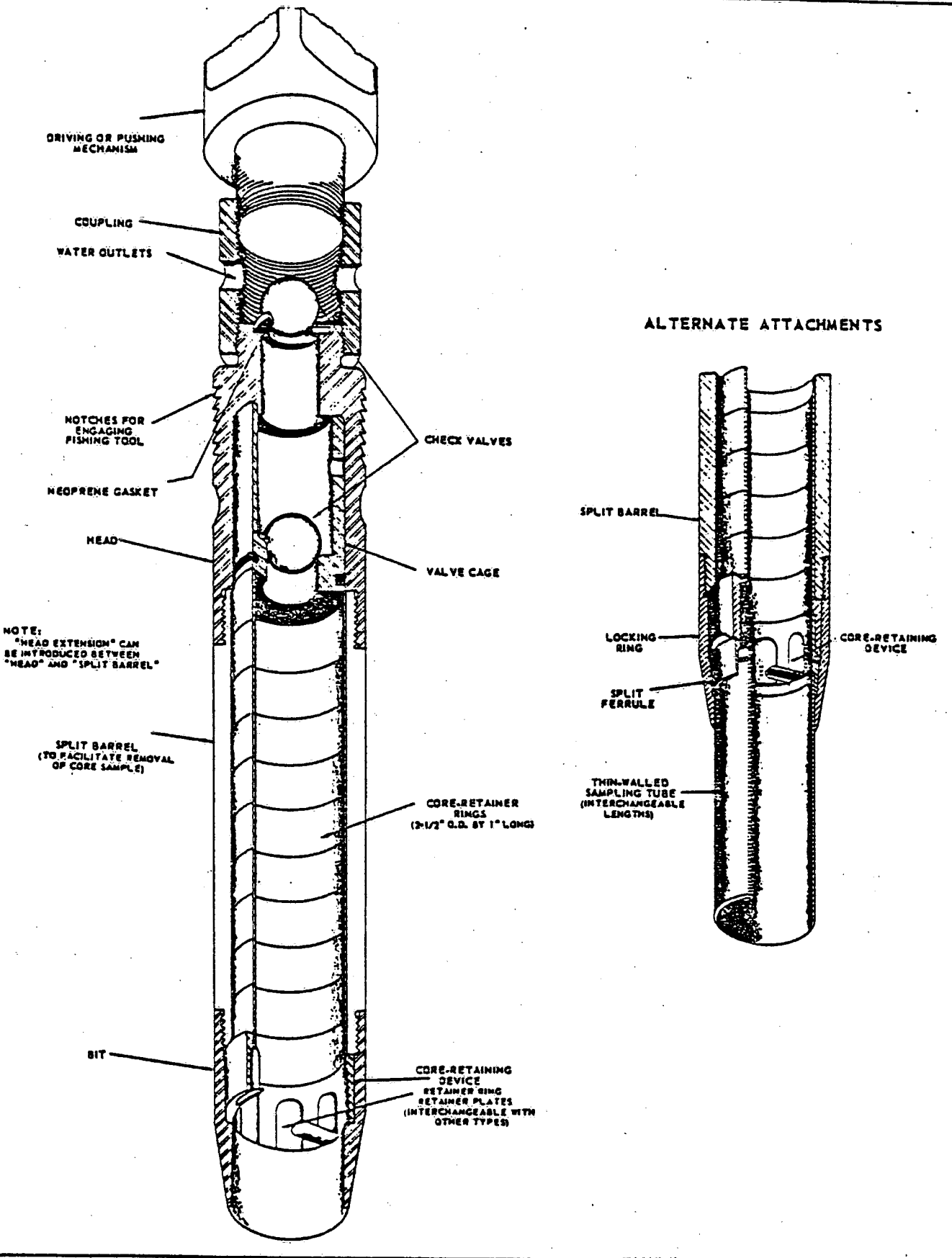
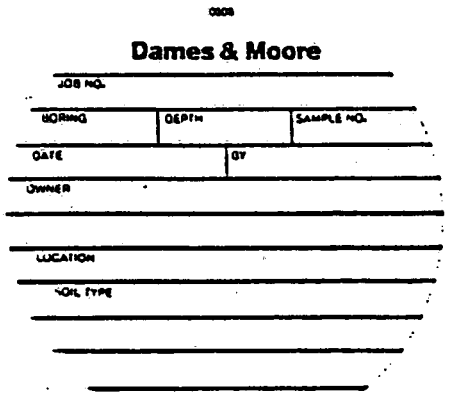


FIGURE 7

DAMES & MOORE TYPE U SAMPLER

DAMES & MOORE
FORMER RARITAN ARSENAL
EDISON, NEW JERSEY
FOR
U.S. ARMY CORPS OF ENGINEERS



SAMPLE CONTAINER LABEL FOR CHEMICAL ANALYSIS

DAMES & MOORE

PHONE NO. _____

JOB NO. _____

OWNER _____

LOCATION _____

BORING	DEPTH	SAMPLE NO.
DATE	TIME	COLLECTOR

Comments _____

FIGURE 8
SOIL SAMPLER CONTAINER LABEL

DAMES & MOORE
FORMER RARITAN ARSENAL
EDISON, NEW JERSEY
FOR
U.S. ARMY CORPS OF ENGINEERS

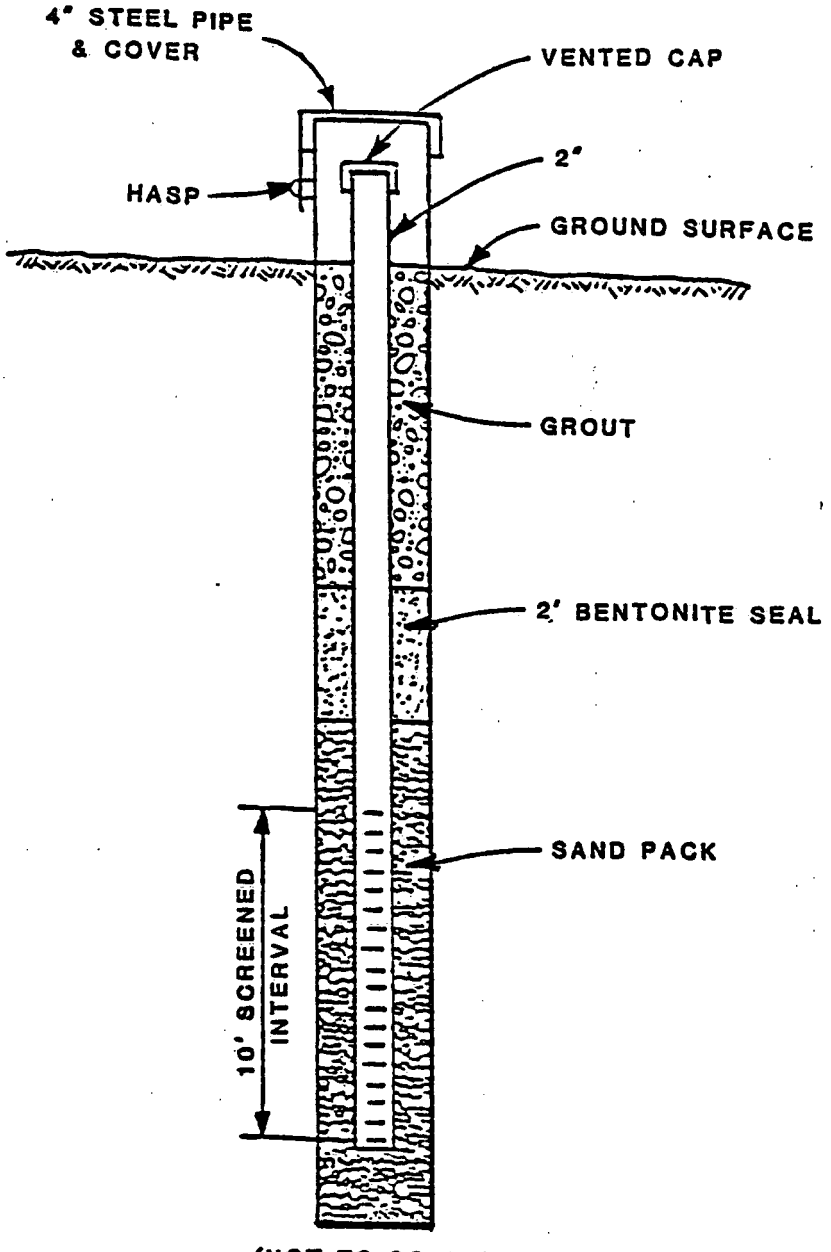


FIGURE 9

TYPICAL MONITORING WELL INSTALLATION

DAMES & MOORE
FORMER RARITAN ARSENAL
EDISON, NEW JERSEY
FOR
U.S. ARMY CORPS OF ENGINEERS

GROUND SURFACE ELEVATION _____

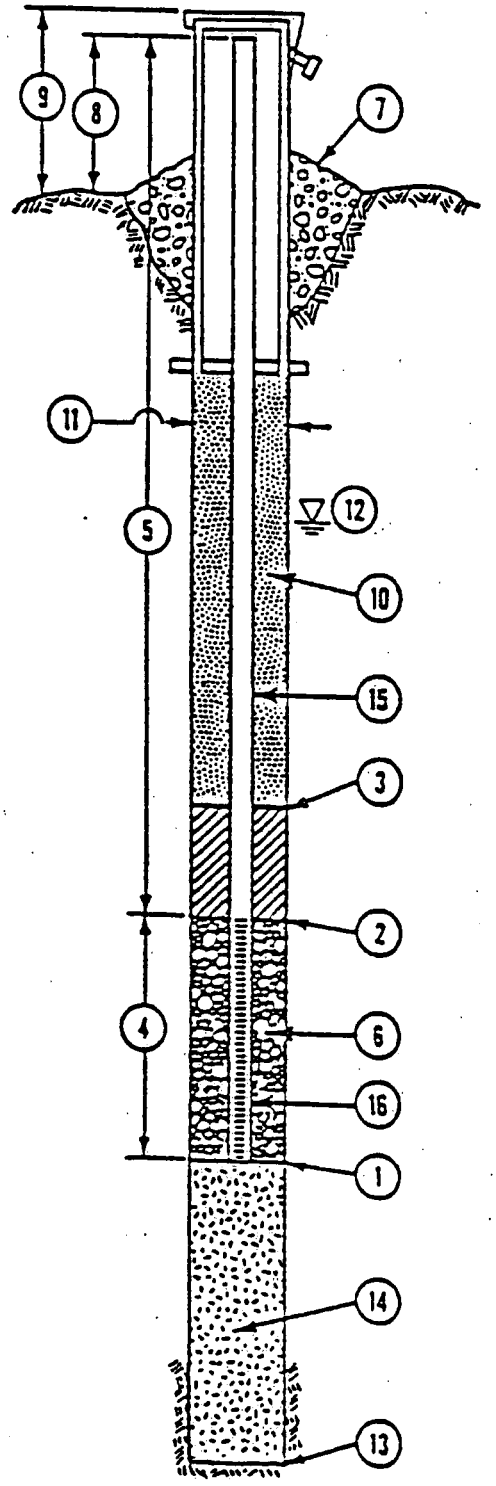
TOP OF WELL CASING ELEVATION _____

JOB NUMBER _____

BORING NUMBER _____

DATE _____

LOCATION _____



(1) DEPTH TO BOTTOM OF WELL POINT OR SLOTTED PIPE _____ FEET. *

(2) DEPTH TO BOTTOM OF SEAL (IF INSTALLED) _____ FEET. *

(3) DEPTH TO TOP OF SEAL (IF INSTALLED) _____ FEET. *

(4) LENGTH OF WELL SCREEN _____ FEET.
SLOT SIZE _____.

(5) TOTAL LENGTH OF PIPE _____ FEET AT _____ INCH DIAMETER.

(6) TYPE OF PACK AROUND WELL POINT OR SLOTTED PIPE _____.

(7) CONCRETE CAP. YES NO (CIRCLE ONE)

(8) HEIGHT OF WELL CASING ABOVE GROUND _____ FEET.

(9) PROTECTIVE CASING? YES NO (CIRCLE ONE)
HEIGHT ABOVE GROUND _____ FEET.
LOCKING CAP? YES NO (CIRCLE ONE)

(10) TYPE OF UPPER BACKFILL _____.

(11) BOREHOLE DIAMETER _____ INCHES.

(12) DEPTH TO GROUND WATER _____ FEET. *

(13) TOTAL DEPTH OF BOREHOLE _____ FEET. *

(14) TYPE OF LOWER BACKFILL _____.

(15) PIPE MATERIAL _____.

(16) SCREEN MATERIAL _____.

*(DEPTH FROM GROUND SURFACE)

FIGURE 10

MONITOR WELL INSTALLATION DETAIL

DAMES & MOORE
FORMER RARITAN ARSENAL
EDISON, NEW JERSEY
FOR
U.S. ARMY CORPS OF ENGINEERS

PARAMETER	WELL VOLUME EXTRACTED									
	1	2	3	4		6	7	8	9	10
SPECIFIC CONDUCTANCE (TEMPERATURE CORRECTED) ± 10 umhos/cm										
pH: ±0.1 pH UNIT										
TEMPERATURE: ±0.5 C										
COLOR										
ODOR OF DISCHARGE										

FIGURE 11
STABILIZATION TEST

DAMES & MOORE
FORMER RARITAN ARSENAL
EDISON, NEW JERSEY
FOR
U.S. ARMY CORPS OF ENGINEERS

DAMES & MOORE CHAIN-OF-CUSTODY RECORD

Sample Source & Client						Field Personnel (Signature)
Project Title					Job No.	
Date	Time	Sample I.D. No.	Sample Type	No. of Containers	Sampling Site	Remarks

Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time
Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	Received by: (Signature)	Date	Time

FIGURE 12
DAMES & MOORE CHAIN-OF-CUSTODY RECORD

DAMES & MOORE
FORMER RARITAN ARSENAL
EDISON, NEW JERSEY
FOR
U.S. ARMY CORPS OF ENGINEERS

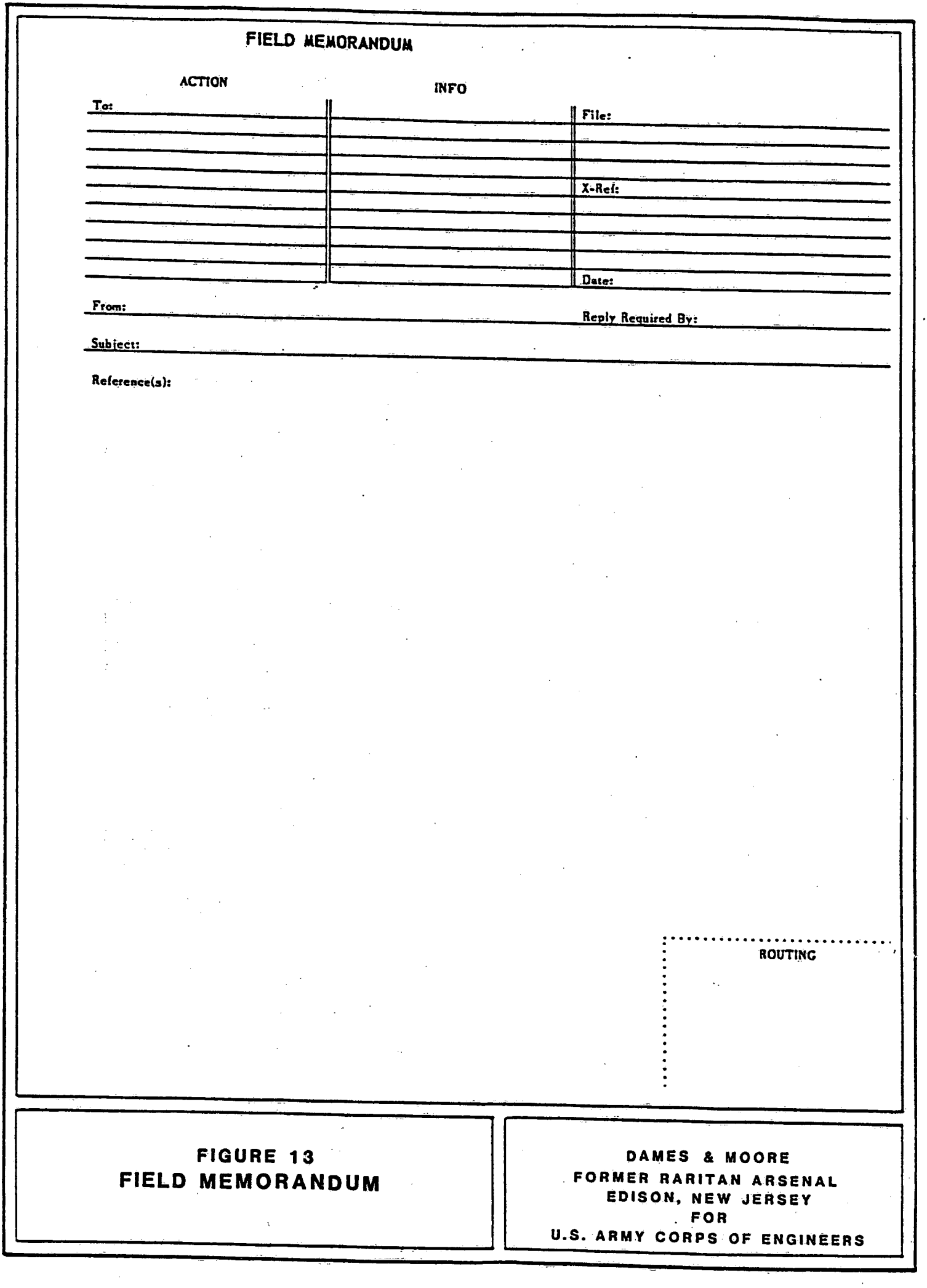


FIGURE 13
FIELD MEMORANDUM

DAMES & MOORE
FORMER RARITAN ARSENAL
EDISON, NEW JERSEY
FOR
U.S. ARMY CORPS OF ENGINEERS

APPENDIX A

SAFETY PLAN SUPPLEMENT FOR

FORMER RARITAN ARSENAL, EDISON, NEW JERSEY

APRIL 1991

SUBMITTED TO:

DAMES and MOORE

1550 Northwest Highway

Park Ridge, Il. 60068

SAFETY PLAN SUPPLEMENT for

Former Raritan Arsenal, Edison, New Jersey

Feasibility Study (RI/FS)

April 1991

SUBMITTED BY:

UXB INTERNATIONAL, INC.

14800 CONFERENCE CENTER DRIVE,

SUITE 100

CHANTILLY, VIRGINIA 22021-3806

Former Raritan Arsenal,

Unexploded Ordnance (UXO)

Safety Plan Supplement

1. INTRODUCTION

UXB International, Inc. (UXB) has developed this Health and Safety Plan Supplement for Dames and Moore (D&M) for the purpose of conducting Unexploded Ordnance (UXO) reconnaissance during intrusive and non-intrusive investigations within the boundaries of Former Raritan Arsenal, Edison, New Jersey. The following pages of this supplement are developed to address procedures, and safety protocols for investigations in potential UXO areas.

****

WARNING

Former Raritan Arsenal, Area #5 is a disposal site for Military Chemical Surety Materials and Agent.

This UXO Safety Supplement does not authorize chemical ordnance investigations.

Operations by UXB within the boundaries of Area #5 are not authorized by this Safety Supplement.

If a chemical agent item is encountered on the Arsenal at any time, withdraw upwind from the location, secure the site and notify the U.S. Army Corp of Engineer Representative.

WARNING

****

1.1 PERSONNEL

Resumes and Certificates for the following personnel are provided in section four. UXB personnel for this project are all graduates of the U.S. Naval School of Explosive Ordnance Disposal, Indian Head, Maryland. UXB team personnel are all honorably discharged military members and have never been de-certified under the military Personal Reliability Program. UXB personnel are all graduates of Hazardous Waste and Emergency Response Operations training in accordance with Code of Federal Regulations (CFR) Part 29, Section 1910.120 and are enrolled in a medical surveillance program.

The following personnel meet and exceed the minimum requirements listed in the statement of work.

UXB UXO Site Supervisor	Mr. David Dyess
UXB UXO Specialist	Mr. Dan Stephens
UXB UXO Specialist	Mr. Bruce Moe

1.2 PERSONNEL ASSIGNMENTS

The U.S. Army Corps of Engineers (USACE) requires two UXO Technicians for UXO field operations where intrusive investigations will take place. This supplement recognizes the two man concept for each intrusive procedure addressed.

a. SITE SUPERVISOR - The UXB Site Supervisor (UXBSS) has overall responsibility for UXB personnel and their performance while on site. The UXBSS is responsible for complying with the procedures and techniques addressed in the D&M Health and Safety Plan and this supplement. THE UXBSS coordinates field tasks and schedules with the D&M Project Manager (PM) on a daily basis.

The UXBSS receives guidance and instructions from D&M PM for site actions to exclude UXO operational safety. The UXBSS will coordinate site activities from the D&M Command Post and maintain a radio link with the D&M Safety Officer (SO). The UXBSS is dedicated to the project during UXO operational tasks. The UXBSS is responsible for determining the final hazard assessment on all UXO encountered.

b. UXO TECHNICIANS - TWO UXO qualified personnel responsible for safely conducting escort and intrusive operations as assigned by the UXBSS.

This UXB two-person team can safely support one intrusive investigation and two non-intrusive activities. Each additional intrusive investigation will require an additional two man team.

1.3 PERSONAL PROTECTION EQUIPMENT

Personal Protection Equipment (PPE) for UXB personnel is Level D during UXO search and escort. Upgrade is required to a modified or higher level of protection through field monitoring results or site specific guidance of the Health Safety Plan.

1.4 EQUIPMENT

The following major equipment items will be required during the investigation phase:

EQUIPMENT	NUMBER
White's Eagle II Metal Detector	1
Foerster Ferex Ordnance Locator	1
EOR/Survey Kit	1
Trucks P/U 1/2 ton	2
Motorola HT-90 Portable Radios	4
Cellular Telephone	1
Level D PPE	Multiple

2.0 TECHNICAL APPROACH

There are two basic methods of search for an area suspected of unexploded ordnance (UXO) contamination. These methods are:

a. GEOPHYSICAL SEARCH - Using magnetometers or metal detectors to examine the surface and subsurface area in a non-intrusive manner.

b. VISUAL SEARCH - Usually conducted simultaneously with the above methods. Entails visually observing the areas being searched to locate ordnance on the surface or surface indications of the presence of subsurface ordnance (e.g. projectile entry holes or burial trenches).

The two survey methods described above will be used alone or in combination to conduct investigations depending on the specific operation to be conducted (e.g. well installation, shallow soil sampling and escort).

2.1 GEOPHYSICAL SEARCH

USACE requires that two distinct methods of geophysical survey be conducted. The Foerster Ferex Ordnance Locator will be used, in conjunction with the White's commercial metal detector, for all subsurface geophysical surveys. The following are descriptions of these two electronic detectors:

a. Foerster Ferex Electromagnetic Detector - The Foerster Ferex Ordnance Locator is the most recent military approved locator and is in use by the U.S. Military EOD forces, designated the MK 26 Ordnance Locator, for detecting subsurface ordnance items. The locator is a hand-held unit and uses 2 flux-gate magnetometers, aligned and mounted a fixed distance apart to detect changes in the earth's ambient magnetic field caused by ferrous metals.

Both an audio and metered signal are provided to the operator. The metered signal indicates whether the disturbance is geodetic or metal-related. The detection capability of the Foerster Ferex is dependent on the size of the item versus its depth.

The Foerster Ferex is capable of ordnance location to the following depths:

ITEM	DEPTH
Small Arms Round	1 ft
Hand Grenade	2 ft
Anti-Personnel Mine	3 ft
Anti-Tank Mine	4.5 ft

ITEM	DEPTH
Medium Projectile	10 ft
Small Bomb	15 ft
Large Bomb	19 ft

Although the Foerster Ferex Ordnance Locator will detect disturbances caused by changes in soil conditions, its ability to detect metallic items is not affected by local soil conditions.

b. WHITE'S EAGLE II METAL DETECTOR - A man-carried, microprocessor controlled metal detector with a Liquid Crystal Display and a keypad user interface. This metal detector operates on the induction principle whereby a transmitter coil induces eddy currents within buried metal and these induced eddy currents are received by a receiver unit. The advantage of this detector is that it can detect both ferrous and non-ferrous metals.

The instruments detailed above will be used, during investigations, to locate subsurface metallic objects and UXO. They are very effective in areas where there is sparse to heavy metallic contamination and, conversely, of limited usefulness in areas that are contaminated with thick layers of miscellaneous metallic debris, such as landfills.

Sites at Raritan Arsenal are known not to be heavily contaminated with metallic debris on the surface, normal geophysical survey methods can be used. The following types of geophysical searches will be employed throughout the Arsenal investigation sites.

1. UXO Technician Escort Services for Samplers - To ensure the safety of all field samplers working in an area suspected to be contaminated with UXO, the path to be traveled by the field technician will be searched for hazards by a UXO Technician, using an ordnance locator, ahead of the field technician.

A visual and geophysical search of the proposed route will be conducted for UXO and other hazardous items. If UXO or hazardous items ares encountered, they will be marked and identified by position and a clear route around the hazard will be selected.

Standard operating procedures, tailored to the specific requirements for each site may be modified by UXBSS as dictated by site condition and followed by UXB Technicians assigned to the project. For the purposes of escorting single field technicians or small field teams, a single qualified UXO Technician is sufficient provided the UXO Technician has radio communication with the established D&M Command Post. The UXO Technician will not be allowed to perform any intrusive UXO operations, such as excavation or removal of UXO, while working alone. The UXO Technician working alone will only be authorized to locate, flag and avoid suspected hazards to ensure the safety of the field samplers.

2. UXO Team Search and Clearance for Well/Boring Sites - The following steps will be followed to ensure the safety of all personnel involved with drilling wells and borings at sites potentially contaminated with UXO:

a. A search team consisting of two UXO Technicians will conduct a surface visual sweep of the proposed route the drilling rig will take from the road to the drilling site and search a path fifteen feet wide. A circle of sixty feet in diameter centered on the proposed drilling location will also be searched.

b. If UXO is encountered, the team will attempt to find a clear route around the hazardous item. If this cannot be done, because of rough terrain or an abundance of hazardous items in the area, UXO that can be moved remotely will be placed outside of the area to be searched. No UXO will be moved without approval of the UXBSS.

c. If UXO encountered is not safe to be moved, the UXBSS will mark the UXO location, plot the location on a map and contact the D&M PM to receive guidance from the USACE representative for the items final disposition action.

d. Using marking stakes and surveyors tape as necessary, the UXB Technicians will mark the outer perimeter of the proposed searched/cleared safe work area.

e. Two UXB Technicians will then conduct a geophysical search of this area, using a Foerster Ferex Ordnance Locator, to locate metallic items to a minimum depth of three feet. All metallic contacts will be marked with paint, an alternate clear and safe path for the drilling rig will be selected for use.

f. If an alternate path cannot be found, the marked locations will be hand excavated by UXB Technicians to a maximum depth of three feet for the purpose of contact characterization. Buried ordnance will be handled in accordance with (b) and (c) above.

g. During well installation the UXB team will dig the first two feet using a hand auger or post hole digger. The team will perform a down hole search of the point using the Forester Ferex Ordnance Locator assembled in the bore hole mode. This procedure will insure that the well/bore site is clear and void of UXO for the first two feet and the next two subsurface feet. If no significant metallic contacts are encountered the drilling crew will be allowed to set up and begin drilling in increments of two feet. If a significant metallic contact is discovered, the drilling site will be abandoned, moved at least 10 feet, and the above procedure repeated. Each two feet of mechanized drilling will require subsurface scanning to a final depth of 12 feet.

2.2 EXCAVATION AND CLEARING EQUIPMENT

The only excavation equipment required for this project are manual hand tools of various types (shovels, spades, post-hole digger and trowels). Brush clearing equipment may be required by manual and mechanized means as required by site conditions and objective.

3.0 SEARCH PROCEDURES

UXO search procedures may be modified by the UXOSS as dictated by individual site conditions. UXO search teams will maintain high awareness for signs of possible chemical ordnance. If chemical ordnance or agents are suspected, take no action and withdraw from the area. Notify the USACE Representative for further guidance. All search procedures will be conducted in PPE Level D.

3.1 GEOPHYSICAL SEARCH PROCEDURES

a. ESTABLISH THE COMMAND POST - A command post (CP) will always be established whenever field operations are being conducted. The purpose of the CP is to allow a responsible person, who is familiar with on-site operations, to be present and to take appropriate action in case of an emergency at the work site. The person manning the CP will have communications with the field crews and outside assistance (fire dept., ambulance, etc.) at all times. The CP will be a sheltered place, such as a trailer or vehicle, located within the boundaries of the Raritan project.

b. ESTABLISH THE SEARCH AREA - Prior to conducting the geophysical search the boundaries of the area must be established. Field crews will use aerial photos, maps, arsenal records and existing landmarks to locate the desired project site and sampling objective. The UXO team will mark-out site boundaries with wooden stakes. Because the exact sampling locations are not yet determined, the D&M PM will be required to assist the UXBSS in locating the sampling points selected.

c. CONDUCT THE SEARCH - The geophysical search team will consist of two UXB/UXO Technicians. One Technician will carry the Foerster Ferex Ordnance Locator and the other will carry a White's Eagle II Metal Detector. The UXO team will search predetermined lanes and record all contacts on a site map. All positive contacts will be marked with red paint to facilitate relocating the contact for excavation.

3.1.1 VISUAL SURVEY PROCEDURES

a. GENERAL - Unless otherwise specified in this safety supplement or ordnance SOP, visual surveys will be conducted in conjunction with geophysical search.

b. CONDUCT THE SEARCH - The visual search team will consist of two UXB/UXO Technicians.

Some sites may be denuded enabling each individual to visually sweep an area of up to seven feet wide. Sites where vegetation is thick will require limited brush clearing. The team will mark and search access/egress lanes of drilling sites selected and record all UXO and hazards encountered on a site map. All located UXO will be marked with red paint to facilitate relocation and avoidance.

3.2 HAND EXCAVATION PROCEDURES

Hand excavation of unknown contacts may occur when avoidance is not practical due to terrain, vegetation or quantity of contacts. Excavation for the purpose of contact characterization may be authorized by the UXBSS on a site-by-site case.

A team of two UXB/UXO Technicians will approach the excavation point with suitable hand tools and the ordnance locator best able to detect the metallic unknown contact to be excavated. Upon arrival at the excavation site, the unknown contact will be reestablished using the ordnance locator. One technician will carefully begin to excavate the soil layers covering and concealing the identity of the contact. The other UXB/UXO Technician will man the ordnance locator and frequently scan the contact to estimate its depth and position below the excavation point. During excavation the UXB/UXO Technician with ordnance locator will withdraw during intrusive excavation a distance of 25 feet upwind and assume a safety observation position. When the object is located, it will carefully be uncovered to reveal identity using standard Explosive Ordnance Reconnaissance (EOR) procedures, a detailed hazard assessment will be performed at this time.

If the object is ordnance it will be flagged and the USACE representative notified. No UXO will be moved without approval of the UXBSS. Upon identification of a non-UXO item (scrap metal, cans, wire, bolts) the item will be removed, and disposed of off site in an approved refuse container. The excavation site will then be backfilled, using hand tools.

3.3 EXPLOSIVE ORDNANCE RECONNAISSANCE (EOR) PROCEDURE:

UXO/EOR tasks include, but are not limited to the following:

Investigate - The investigation of suspect sites is performed to confirm or eliminate the UXO suspect assessment.

Diagnose - The UXB Technician will determine the approximate location, size and type of UXO through visual and geophysical investigation techniques.

Locate - If a UXO is not visible on the surface but evidence suggests a subsurface possibility, the UXB Technician is to determine through electronic subsurface search the approximate location, calculated depth, and position of the item.

Mark - The UXB Technician must clearly mark each UXO and or suspect item as soon as safely possible. Marking is extremely important. Markers must be plainly visible and easily recognized by all site personnel and team members.

Report - If possible, an accounting of recoverable information pertaining to: nomenclature, fuzing, explosive filler, measurements, painting and markings, hazard assessment, location, and specific recommended ordnance safeties relating to approach are to be documented. Movement of UXO is not authorized by one individual UXB Technician.

Protect - The UXB Technician must initiate and supervise protective measures which are essential for the protection of life and property. The EOR assessment is to determine if total or partial evacuation of a work area is required or if a modification to procedures should be required to continue scheduled operations.

4.0 RESUMES and CERTIFICATES

Resumes and Certificates of UXB personnel are attached on the following pages.

5.0 APPENDIX - A

Appendix - A--Provides information on safety concepts and basic considerations relating to Unexploded Ordnance in general. These safety concepts and considerations are not specific to a site or proposed operation on the Arsenal. The intent of this Appendix is to provide general guidance and additional information for UXB field teams should a need arise.

SECTION FOUR

UXB PERSONNEL RESUMES and CERTIFICATES

DAVID R. DYESS
EXPLOSIVE ORDNANCE DISPOSAL TECHNICIAN
SAFETY OFFICER

EDUCATION: Graduate, U.S. Naval School of Explosive Ordnance Disposal, 1972
Graduate, OSHA 40 Hour Health and Safety Course (29 CFR 1910.120)

EMPLOYMENT HISTORY:

October 1989 - Present, UXB International, Inc.
August 1969 - August 1989, U.S. Air Force

PROFESSIONAL EXPERIENCE:

October 1989 - Present
UXB International Inc.
14800 Conference Center Dr., Suite 100
Chantilly, Va. 22021

Explosive Ordnance Disposal Technician conducting ordnance location, identification and disposal operations at NAS Brunswick, Me., Crab Orchard Army Ammunition Plant, Il., and Tooele and Dugway Proving Grounds, Ut. Site Supervisor during toxic chemical agent monitoring and UXO location operations accomplished in Level "A" Personal Protective Equipment at the "G" Street Salvage Yard Remediation, Aberdeen Proving Ground, Md., Edgewood Area.

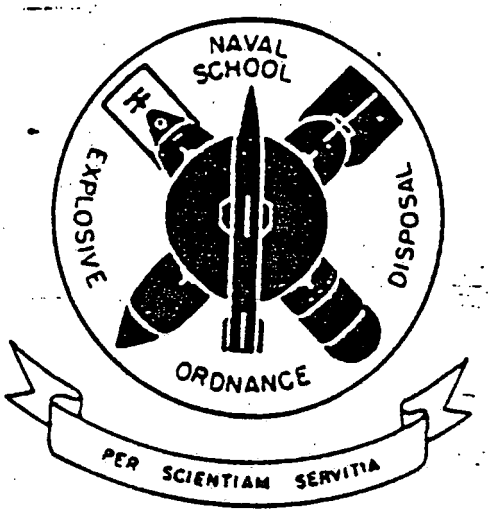
August 1969 - August 1989
U.S. Air Force
Various Commands

Explosive Ordnance Disposal Technician, Range Safety Officer, and EOD Instructor at various commands. Conducted range clearance and ordnance disposal operations Thailand and Lakeside Range Ut., provided EOD support during eleven aircraft crash cleanups, and served as Senior Instructor for rockets and projectiles at the U.S. Naval School of EOD.

ADDITIONAL INFORMATION:

Mr. Dyess is currently an employee of UXB International, Inc. He is a Master Rated EOD Technician with over eighteen years of operational EOD experience.

Naval School
Explosive Ordnance Disposal



This certifies that

SERGEANT DAVID B. DYESS, [illegible], USAF

having successfully completed the prescribed course of study

for [illegible] Explosive Ordnance Disposal [illegible]

is awarded this

Certificate

this 28TH day of APRIL A.D. 1972

D. H. Moody

L. H. MOODY, JR., USN

COMMANDING OFFICER

NOW-NAVORDSTA-1540 2

Certificate of Training

UXB International, Incorporated

proudly presents this award for educational achievement to

David Dyess

for satisfactorily completing the course of

8 Hour Refresher Health and Safety Training for Hazardous Waste Operations

14 December, 1990

Instructor

U X B
INTERNATIONAL

14800 Conference Center Drive, Suite 100, Chantilly, VA 22021-3806 (703)803-8904

WASHINGTON OCCUPATIONAL HEALTH ASSOCIATES, INC.
Suite 410
1120 19th Street, N.W.
Washington, D.C. 20036
(202) 463-6698

MEDICAL MONITORING EXAMINATION
EMPLOYER NOTIFICATION

Employee DYESS, DAVID Date 9-21-90

Employer UNEXPLODED BOMBS INTERNATIONAL

I have reviewed the results of this employee's medical monitoring examination and certify that the record (☑ is/☐ is not) complete. (Tests not performed: _____)
(_____)

Please check all sections that are applicable to this examination:

Applicable	Not Applicable	
☐	☑	**Asbestos Certification — Opinion of Increased Risk:**

This individual was examined as per OSHA Standards (29 CFR 1910.1001 and 29 CFR 1926.58. In my opinion, (☐ there is/☐ there is no) medical condition that places the individual at increased risk from exposure to asbestos, tremolite, anthophyllite, or actinolite.

☑ ☐ **Respirator Certification:**

This individual has been examined as per OSHA Standards (29 CFR 1910.134) and found (☑ qualified/☐ not qualified) to use a respirator.

☐ ☑ **Respirator Fit Testing:**

This individual has been examined as per OSHA Standards (29 CFR 1910.134) and has (☐ passed/☐ not passed) a qualitative fit test.

☑ ☐ **Hazardous Waste Certification:**

This individual has been examined as per OSHA Standards (29 CFR 1910.120). In my opinion, this individual is:

- ☑ qualified for full participation in hazardous waste site work when conducted under the conditions of adequate training and a health and safety plan.
- ☐ qualified with limitations that restrict full participation in hazardous waste site work as described below.
- ☐ not qualified for any direct work with hazardous waste or hazardous waste sites as described below.

Comments: (Please describe any work limitations including functional and environmental limitations, whether temporary or permanent, pending medical evaluation, etc.)

_____

_____

I have informed the employee about medical conditions discovered during my examination that require further examination or treatment.

Physician Name: (Print) RONALD FINE (Signature) Ronald Fine MD

Date 10/6/90

WHITE - EMPLOYEE
YELLOW - PHYSICIAN
PINK - EMPLOYEE

DANIEL E. STEPHENS
UNEXPLODED ORDNANCE TECHNICIAN

EDUCATION: Graduate, U.S. Naval School of Explosive Ordnance Disposal, 1983
Graduate, 40 Hour OSHA Health and Safety Training (29 CFR 1910.120)

EMPLOYMENT HISTORY:

December 1988 - Present, UXB International, Inc.
March 1983 - March 1988, U.S. Air Force

PROFESSIONAL EXPERIENCE:

December 1988 - Present
UXB International, Inc.
14800 Conference Center Dr., Suite 100
Chantilly, Va. 20021

Site Supervisor and Safety Officer responsible for managing the safe location, identification, and disposal of UXO during the surface and subsurface UXO survey and clearance at the following major sites:

- Slesse Demolition Range, Chilliwack, Canada. Supervised the UXO clearance of this 17 acre live-fire range.
- Sarcee Gunnery Range, Calgary, Canada. Supervised the UXO clearance of this 1000 acre live-fire artillery range.
- Meaford Artillery Range, Ontario, Canada. Supervised the UXO clearance of this 1260 acre live-fire artillery range.

UXO Technician performing UXO location, identification, and removal operations at the former Sioux Ammunition Aepot, Sidney, Ne.

March 1983 - March 1988
U.S. Air Force
Various Commands

Explosive Ordnance Disposal Technician and Sweep Team Leader for bombing range UXO location, identification, and disposal operations. Also provided EOD response to ordnance and explosives accidents.

ADDITIONAL INFORMATION:

Mr. Stephens is currently an employee of UXB International, Inc. He is a Senior Rated EOD Technician with over seven years of operational EOD experience.

Naval School
Explosive Ordnance Disposal

This certifies that

Airman First Class
Daniel E. Stephens, 268-60-9946, USAF

having successfully completed
the prescribed course of study for

EXPLOSIVE ORDNANCE DISPOSAL SPECIALIST - G5ABN46430
PDS-CID

is awarded this
Certificate

this 1st day of March A.D. 1983

James C. Blanton
JAMES C. BLANTON, CDR, USN
COMMANDING OFFICER

Certificate of Training

UXB International, Incorporated

proudly presents this award for educational achievement to

Dan Stevens

for satisfactorily completing the course of

8 Hour Refresher Health and Safety Training for

Hazardous Waste Operations

14 December, 1990

Instructor

U X B
INTERNATIONAL

14800 Conference Center Drive, Suite 100, Chantilly, VA 22021-3806 (703)803-8904

WASHINGTON OCCUPATIONAL HEALTH ASSOCIATES, INC.
Suite 410
1120 19th Street, N.W.
Washington, D.C. 20036
(202) 463-6698

MEDICAL MONITORING EXAMINATION
EMPLOYER NOTIFICATION

Employee STEPHENS, DANIEL Date 10-25-90

Employer UNEXPLODED BOMBS INTERNATIONAL

I have reviewed the results of this employee's medical monitoring examination and certify that the record (☑ is/☐ is not) complete. (Tests not performed: _____)
(_____)

Please check all sections that are applicable to this examination:

Applicable	Not Applicable	
☐	☑	**Asbestos Certification — Opinion of Increased Risk:**

This individual was examined as per OSHA Standards (29 CFR 1910.1001 and 29 CFR 1926.58. In my opinion, (☐ there is/☐ there is no) medical condition that places the individual at increased risk from exposure to asbestos, tremolite, anthophyllite, or actinolite.

☑ ☐ **Respirator Certification:**

This individual has been examined as per OSHA Standards (29 CFR 1910.134) and found (☑ qualified/☐ not qualified) to use a respirator.

☐ ☑ **Respirator Fit Testing:**

This individual has been examined as per OSHA Standards (29 CFR 1910.134) and has (☐ passed/☐ not passed) a qualitative fit test.

☑ ☐ **Hazardous Waste Certification:**

This individual has been examined as per OSHA Standards (29 CFR 1910.120). In my opinion, this individual is:

☑ qualified for full participation in hazardous waste site work when conducted under the conditions of adequate training and a health and safety plan.

☐ qualified with limitations that restrict full participation in hazardous waste site work as described below.

☐ not qualified for any direct work with hazardous waste or hazardous waste sites as described below.

Comments: (Please describe any work limitations including functional and environmental limitations, whether temporary or permanent, pending medical evaluation, etc.)

_____

_____

I have informed the employee about medical conditions discovered during my examination that require further examination or treatment.

Physician Name: (Print) Dunn (Signature) [signature]

Date 11/7/90

WHITE - EMPLOYER
YELLOW - PHYSICIAN
PINK - EMPLOYEE

BRUCE M. MOE
UXO Technician
UXB INTERNATIONAL

EDUCATION: Graduate, U.S. Naval School of Explosive Ordnance Disposal, 1984
Graduate, OSHA 40 Hour Health and Safety Training (29 CFR 1910.120)
High School Graduate

EMPLOYMENT HISTORY:

April 1987 - Present, UXB International, Inc.
September 1982 - May 1986, U.S. Navy

PROFESSIONAL EXPERIENCE:

April 1987 - Present
UXB International, Inc.
14800 Conference Center Dr.
Suite 100
Chantilly, Va. 22021

Explosive Ordnance Disposal Technician and Quality Assurance Manager for the Bombing Range Maintenance Project, NAS Fallon, Nv. Directs sweep teams in the location, identification, collection, inert certification and removal of ordnance debris. Accompanies and assists government quality assurance inspectors during range clearance certifications. Directed 30 Ordnance Workers while conducting a 3,800 acre surface sweep and subsurface survey of the Sarcee, Canada Artillery Range. **UXO Site Supervisor** directing and coordinating UXO location, identification and disposal operations at Umatilla Army Depot Activity, Or., Savanna Army Depot Activity, Il., and Tooele and Dugway Proving Grounds, Ut.

September 1982 - May 1986
U.S. Navy, EOD Mobile Unit One
Barbers Point, Hawaii

Explosive Ordnance Disposal Technician and member of a 4 man EOD detachment. Conducted frequent ordnance clearance operations on the Kahoolawe Island, HI. Bombing Range. Duties included conducting land surveys of the naval target range, identification and hazard assessment of a wide variety of ordnance, and disposal of UXOs by detonation. Also responded to ordnance and explosives related emergencies throughout the Pacific region.

NAVY OCCUPATIONAL/TRAINING AND AWA[illegible]
NAVPERS 1070/604 (Rev. 1/78) (S/N 0106 LF-010-[illegible])

1 NAVY EXPERIENCE (MOS/NEC/RATING)				2 [illegible]
SEP 0 8 1982	DG 9770	(XXX)	[illegible]	
82DEC14	0000	0000	[illegible]	
840CT01	0000	5332	[illegible]	

3 RECORD OF NAVY SERVICE SCHOOLS ATTENDED (CLASS R, A, C, F, P, V AND E)

COURSE TITLE AND SCHOOL LOCATION
HULL MAINTENANCE TECHNICIAN "HTA" SCHOOL NDCTC, PHILADELPHIA, PA 19112

EARNED NEC	COURSE LENGTH	DATE ENROLLED
NA	10 WEEKS	82SEP01
DATE COMPLETED	FINAL MARK	CLASS STANDING
82DEC14		in a class of

MANNER OF COMPLETION: ☐ GRADUATED ☐ DROPPED FOR
SIGNATURE: R. H. STULL
R. H. STULL, GS1, SUPVMTLPERSCLK, BY DIR

COURSE TITLE AND SCHOOL LOCATION
EOD COURSE
REDSTONE ARSENAL, AL

EARNED NEC	COURSE LENGTH	DATE ENROLLED
0000	5.0	14 FEB 1983
DATE COMPLETED	FINAL MARK	CLASS STANDING
83MAR24	SAT	N/A

MANNER OF COMPLETION: ☐ GRADUATED ☐ DROPPED FOR
SIGNATURE: [illegible]
[illegible] MARTIN, LTJG, USN
PERSUPPDET NAVSTA NS

COURSE TITLE AND SCHOOL LOCATION
SECOND CLASS (A-433-0022) NAVY DIVING AND SAVAGE TRNG CENTER PANAMA CITY FL

EARNED NEC	COURSE LENGTH	DATE ENROLLED
5343	12 WKS	08 APR 83
DATE COMPLETED	FINAL MARK	CLASS STANDING
01JUL83	SAT	in a class of

MANNER OF COMPLETION: ☒ GRADUATED ☐ DROPPED FOR
SIGNATURE: A. B. FARHONOVICH JR., PNCS(SS), USN
MILPERS SUPVR, BY DIR CO

COURSE TITLE AND SCHOOL LOCATION
NAVY EXPLOSIVE ORDNANCE DISPOSAL BASIC A-431-0011, INDIAN HEAD, MD

EARNED NEC	COURSE LENGTH	DATE ENROLLED
5332	24 WKS	[illegible]
DATE COMPLETED	FINAL MARK	CLASS STANDING
05APR83	SAT	NA

MANNER OF COMPLETION: ☒ GRADUATED ☐ DROPPED FOR
SIGNATURE: [illegible]
J. M. BANKS, PNC, USN, OIC

4. TRAINING COURSES COMPLETED

DESCRIPTION OF COURSE, RATE OR NAVPERS NUMBER	DATE COMPLETED	*OFF INIT	DESCRIPTION OF COURSE, RATE OR NAVPERS NUMBER	DATE COMPLETED	*OFF INIT
BMR		[illegible]			
~~3.36~~	170CT82	[illegible]			
FIREMAN 3.76		[illegible]			
MRPO 3&2 (3.6)	170CT82	[illegible]			
~~NAVEDTRA 10056-B1 1F5884~~		[illegible]			
HT 3&2, 3.5	29JAN85	[illegible]			

5. EDUCATIONAL EXPERIENCE LEVEL

GED (HS) EQUIVALENT TEST

DATE PASSED	OFF INITIALS

STATE THAT ISSUED DIPLOMA OR CERTIFICATE

COLLEGE LEVEL GENERAL EXAMS

DATE PASSED	OFF INITIALS

PRESENT LEVEL OF EDUCATION
12 13 14 15 16 17+

NAME (Last, First, Middle)	COMPANY NUMBER	SOCIAL SECURITY NO	BRANCH AND CLASS
HILBRUCK MICHAEL	C161	547-64-0251	USN

Certificate of Training

UXB International, Incorporated

proudly presents this award for educational achievement to

To: Mr. Bruce Moe

for satisfactorily completing the course of

8 Hour Refresher Health and Safety Training for

Hazardous Waste Operations

17 October 1990

Instructor

U X B
INTERNATIONAL

14800 Conference Center Drive, Suite 100, Chantilly, VA 22021-3806 (703)803-8904

EXHIBIT 3-3
PHYSICIAN STATEMENT

FOR EMPLOYEE OR APPLICANT OF UXB

PARTICIPANT NAME: Moe, Bruce DATE OF EXAM 21 June 90
TYPE OF EXAM (preassignment, annual or other):
PARTICIPANT DATE OF BIRTH: 6-17-59
PARTICIPANT SOCIAL SECURITY NUMBER: 397-64-0251
The individual named above has:

1. undergone a physical examination and been found medically
   (✓) qualified for hazardous waste site work
   ( ) not qualified for hazardous waste site work
   and
2. undergone a physical examination as per OSHA (29 CFR 1910.134 (b) (10) and been found medically
   (✓) qualified to use a respirator
   ( ) not qualified to use a respirator

Physician Signature

OSHA 1910.134 (b) (10) States that persons should not be assigned to tasks requiring use of respirators unless it has been determined that they are physically able to perform the work and use the equipment. The local physician shall determine what health and physical conditions are pertinent.

If it is the opinion of the examining physician that an examinee is unqualified to perform hazardous waste site work of to wear a respirator the physician should append a further report to this statement which details reasons for the opinion.

Family Health Clinic
PHYSICIAN'S STATEMENT

June 21, 1990

RE: BRUCE MOE

To Whom It May Concern:

Mr. Bruce Moe was in to see me for an exam on 6/22/89. He is qualified for hazardous waste work and also qualified to use a respirator.

If you have any further questions, please feel free to contact me.

Sincerely,

Dave McNamara, M.D.

255 South 1st East, Tooele, Utah 84074

B

SECTION FIVE

APPENDIX - A

Rev 11 Jan 91

U.S. ARMY CORPS OF ENGINEERS, HUNTSVILLE DIVISION

SAFETY CONCEPTS AND BASIC CONSIDERATIONS

UNEXPLODED EXPLOSIVE ORDNANCE (UXO)

There is no "safe" procedure for dealing with UXO, merely procedures which are considered least dangerous. However, maximum safety in any UXO operation can be achieved through adherence to applicable safety precautions and a preplanned approach. Plans shall be based upon the minimum possible exposure, consistent with efficient operations and maximum safety. All personnel engaged in UXO operations shall be thoroughly trained in explosive safety and be capable of recognizing hazardous explosive exposures. Safety must become a firmly established habit when working with UXO.

I. Care must be observed in probing for, moving, and handling UXO. Operations on the UXO should be conducted only after the establishment of a complete plan for the operation involved and careful preparation to insure its implementation.

II. As a general rule, UXO will be detonated in place when the situation allows. All detonation-in-place shall be conducted by electrical means to assure maximum control of the site. No UXO shall be destroyed until it has been positively identified.

A. Make every effort to identify the UXO. Carefully examine the item for markings and other identifying features such as shape, size, and external fittings. However, do not move the item to inspect it. If an unknown UXO is encountered, photographs shall be taken and express-mailed to CEHND-ED-SY, which has access to the TM 60-Series publications.

B. Foreign UXO were returned to the United States for exploitation and disposal. Records search should indicate the possibility of foreign UXO being on the site.

C. If the records search indicates UXO containing military toxic chemical agents may be on the site, a decontamination plan shall be approved prior to entry onto the site.

(1) Any time a suspected chemical UXO is encountered, the 2-man concept is immediately implemented and notification shall be made through proper channels. The UXO shall be secured until the military arrives and assumes ownership.

D. If the situation dictates, protective measures to reduce shock, blast, and fragmentation damage shall be taken. Army Technical Manual (TM) 5-855-1, Fundamentals of Protective Design for Conventional Weapons and associated software program "CONWEP" contains data on blast effects, groundshock, cratering, ejecta, and fragmentation.

(1) For non-fragmenting explosive materials, evacuation distance should be a minimum of 1250 feet.

(2) For fragmenting explosive materials, evacuation distance should be a minimum of 2500 feet. For bombs and projectiles with caliber 5-inch or greater, use a minimum evacuation distance of 4000 feet.

(3) Items with lugs and/or strongbacks and nose and/or tail plate sections should be oriented away from personnel locations.

E. Consideration shall be given to tamping the UXO to control fragments, if the situation warrants. Fragments shall be minimized not only to protect personnel but property such as buildings, trees, etc.

F. Do not allow one person to work alone in disposal operations. At least one person shall be available near the disposal site to give warning and assist in rescue activities in the event of an accident.

(1) Plan for, provide, and know the measures to be taken in the event of an accident.

(2) Provide a designated emergency vehicle in the area in case of an accident or other emergency.

G. Coordination with the appropriate airspace representative shall be conducted and the appropriate notification procedures arranged.

H. A post-search of the detonation site shall be conducted to assure a complete disposal was accomplished.

I. Open burning of explosives and smokeless powder or chemical decomposition of explosives shall not be accomplished without prior approval of the contracting officer.

(1) If loose explosives are to be disposed of by detonation, detonate only one kind of explosive in any one given shot.

(2) Exercise extreme care in handling and preparing high explosives for detonation. They are sensitive to detonation by heat, shock, and friction.

(3) Keep initiating explosives in a water-wet condition at all times until ready for final preparation for detonation. The sensitivity of these explosives is greatly increased when dry.

(4) When disposing of high explosives by detonation, do not approach the disposal site for at least 30 minutes in the event of a misfire.

III. UXO which penetrates the earth to a depth where the force of the explosion is not enough to rupture the earth's surface forms an underground cavity

called a camouflet. Camouflets will be filled with the end product of the explosion, carbon monoxide gas. Camouflet detection and precautions must be considered if records search indicates the site was used as an impact area.

IV. Avoid inhalation of, and skin contact with smoke, fumes, and vapors of explosives and related hazardous materials.

V. Consider UXO which has been exposed to fire as extremely hazardous. Chemical and physical changes may have occurred to the contents which render it much more sensitive that it was in its original state.

VI. Do not depress plungers, turn vanes, or rotate spindles, levers, setting rings, or other external fittings on the UXO. Such action may arm, actuate, or function the UXO.

A. DO NOT dismantle, strip, or subject any UXO to unnecessary movement, except in response to a valid requirement.

B. Before any movement of an UXO, the fuze condition must be ascertained. If the condition is questionable, consider the fuze armed. The fuze is considered the most hazardous component of UXO, regardless of type or condition.

(1) In general, the condition of a BD fuze in an unexploded projectile cannot be determined through examination of its external features. When there is evidence that the projectile has been fired, the BD fuze is considered to be in the armed condition.

(2) Arming wires and popout pins on unarmed fuzes should be secured by taping in place prior to movement.

C. Perform any initial movement of an armed fuze remotely and avoid any unnecessary movement of an armed fuze.

D. When transporting a possible armed fuze, position the fuze in the most neutral orientation possible.

E. Do not subject a mechanical time fuze to any unnecessary movement.

F. Do not unscrew a fuze from a fuze well that does not contain a fuze cavity liner. High explosives may be on the threads.

VII. Do not allow unauthorized or unnecessary personnel to be present in the vicinity of UXO. Limit personnel exposure time. Operations shall always be based upon minimum exposure consistent with efficient operations.

VIII. Do not rely on the color coding of UXO for positive identification of contents. Munitions having none, incomplete, or improper color coding have been encountered.

IX. Avoid the area forward of the nose of a munition until it can be determined that the item is not a shaped charge and High Explosive Anti-tank (HEAT) UXO. The explosive jet can be fatal to great distances forward of the longitudinal axis of the item.

A. Assume any shaped charge munition to contain a piezoelectric (PZ) fuzing system until the fuzing is otherwise identified. A PZ fuze is extremely sensitive, can fire at the slightest physical change, and may remain hazardous for an indefinite period of time.

X. Examine a projectile for the presence or absence of an unfired tracer.

XI. Perform initial movement of an embedded projectile remotely. First movement of an embedded projectile may cause fuze functioning. During this remote operation, precautions shall be taken for a high-order detonation.

XII. Do not inhale the smoke or fumes of burning pyrotechnic or incendiary materials. The fumes and dust from many of these materials are irritating and/or toxic if inhaled.

A. Use sand to smother incendiary fires. Water may induce a violent reaction or be completely ineffective, depending on the mixture.

B. Bury incendiary-loaded munitions in sand when transporting them. This will smother any fire which should start until other corrective action can be taken.

C. Anticipate a high-order detonation when burning pyrotechnics or incendiary-loaded UXO. Safety measures for personnel and property must be based on this possibility.

D. Expended pyrotechnic/practice devices may contain red/white phosphorus residue. Due to incomplete combustion, red and white phosphorus may be present and reignite spontaneously if subjected to friction or if the crust is broken.

E. Do not approach a smoking white phosphorus (WP) UXO. Burning WP may detonate the burster or dispersal explosive charge at any time.

F. Do not transport a WP munition, unless it is immersed in water, mud or wet sand.

G. Extra care shall be taken when uncovering a buried UXO, if records search indicated WP munitions were fired or destroyed in the area. A buried WP munition may be damaged and when exposed to air, may start burning and detonate. An ample supply of water and mud shall be immediately available if excavation reveals a WP UXO. Appropriate protective equipment (leather gloves, face shield, and flame-retardant clothing) and first aid shall also be immediately available.

H. WP UXO shall not be detonated into the ground. The UXO shall be counter-charged on the bottom-center-line.

I. Photoflash powder will react with moisture and generate hydrogen gas, and this reaction may generate sufficient heat or pressure to detonate the UXO. Do not look directly at photoflash UXO during detonation.

J. If loose pyrotechnic, tracer, flare, and similar mixtures are to be transported, they shall be placed in #10 mineral motor oil or equivalent to minimize fire and explosion hazard.

XIII. Assume a practice UXO contains a live charge until it can be determined otherwise.

A. Inert UXO will not be disposed of or sold for scrap until the internal fillers have been exposed and unconfined. Heat generated during a reclamation operation can cause the inert filler, moisture and air to expand and burst sealed casings. Venting or exposure may be accomplished in any way necessary to preclude rupture due to confined pressure.

XIV. Approach an unfired rocket motor from the side. Ignition will create a missile hazard and hot exhaust.

A. Do not expose electrically fired rocket motors within 25-feet of any exposed electronic transmitting equipment or exposed antenna leads.

B. If an unfired rocket motor must be transported, it shall be positioned in the direction which offers the least exposure to personnel in the event of an accident ignition.

XV. Consider an emplaced landmine armed until proven otherwise. It may not be possible to tell, or it may be intentionally rigged to deceive.

A. Many training mines contain firing indicator charges capable of inflicting serious injury.

B. Exercise care with wooden mines that have been buried for a long time. Because of soil conditions, the wood deteriorates and the slightest inadvertent pressure on top may initiate the fuze.

XVI. Do not pack a bomb fuze well with explosives unless it can be positively confirmed that the fuze well does not contain any fuze components.

A. Photoflash bombs must be handled with the same care as black powder, and with even greater care than explosive-loaded bombs.

B. Some practice bombs do not contain any positive safety features. Positively identify and review all safety precautions prior to handling practice bombs.

XVII. The usual method for uncovering buried UXO is to excavate by hand. Hand excavation is the most reliable method for uncovering UXO, but unless the UXO is very near the surface, hand excavation exposes more people to the hazard of detonation for a longer period of time than any other method.

A. Earth moving machinery (EMM) may be used to excavate for buried UXO, if the UXO is estimated to be deeper than 12 inches. EMM shall not be used to excavate within 12 inches of an UXO. When excavation gets within 12 inches of an UXO, hand excavation shall be used to uncover the UXO.

(1) If more than one EMM will be used on the same site, they will be separated by at least 100m during excavation.

B. Excavation shall comply with the provisions of 29 CFR 1926 subpart P.

XVIII. The site shall be surveyed for electromagnetic radiation (EMR) radio frequency (RF) transmitters and appropriate action taken. Safe distances have been established for specific transmitter power and transmitters. These distances shall be made available to the contractor by CEHND-SD-SY, upon request.

circumstances should an attempt be made to drill a hole in a projectile, either through the fuse or the body of the projectile.

XXI. If base-ejection type projectiles must be transported to a disposal area or collection point, the base shall be oriented to the rear of the vehicle and the projectile secured, in the event the ejection charge functions in route.

XXII. If an OEW, with exposed hazardous filler (HE, etc), has to be moved to a disposal area, the item shall be placed in a heavy duty plastic bag to prevent migration of the hazardous filler. Padding should also be added to protect the exposed filler from heat, shock, and friction.

XIII. Do not undertake the handling or disposal of liquid propellant fuels or oxidizers if not familiar with the characteristics of the material.

XXIV. 29 CFR 1926.100(a) requires personnel to wear protective helmets in areas where there is a possible danger of head injury from impact, or from falling or flying objects, or from electrical shock or burns. During field activities on ordnance projects, hardhats need not be worn unless a head injury threat is present.

XXV. Soil samples, test pit excavation, and/or monitoring well installation are sometimes conducted in areas where subsurface UXO may be found. These intrusive activities must be preceded by a magnetometer survey to assure the safety of the sampling crews.

A. Prior to the drilling rig coming on site, a magnetometer and a hand-held auger shall be utilized to assure the drilling spot is clear of subsurface UXO.

(1) After finding an area the magnetometer indicates is clear of detectable UXO, the hand-held auger should be used to start the drill hole. At not more than 2-foot depth, the hand-held auger shall be withdrawn and the

magnetometer probe shall be lowered into the auger hole. This procedure will ensure small UXO items(20mm projectiles and grenades), undetectable from the surface, are now detectable. This procedure shall be repeated until the maximum depth of the hand-held auger.

(2) Borehole monitoring shall continue at 2-foot intervals until virgin soil is encountered.

XXVI. The detection and identification of suspect explosive materials shall be accomplished IAW Chapter 13, TM 9-1300-214, "Military Explosives".

ELECTROMAGNETIC RADIATION (EMR) HAZARDS

UNEXPLODED EXPLOSIVE ORDNANCE (UXO)

The use of electroexplosive devices (EED) susceptible to EMR devices in the radio frequency (RF) range, that is, radio, radar, and television transmitters, has become almost universal. Radio frequency electromagnetic radiation consists of waves of electrical energy at radio transmission frequencies. These waves are radiated in a line-of-sight from the antennas of electronic devices that transmit radio, radar, television, or other communication or navigation radio frequency signals. The energy is usually equally radiated in all directions; however, certain types of antennas focus the energy, transmitting it in a single direction or sector only. EMR (RF) can also be reflected from large metallic surfaces or objects into areas not directly reached by the line-of-sight-radiated electric energy.

Under highly undesirable conditions, enough of the energy may be picked up by portions of the EED*, associated circuitry, or related objects acting as receiving antennas, to initiate the EED.

* [An EED is used to ignite a limited quantity of explosive, propellant, or pyrotechnic material contained in the device. The actuation of the EED is produced by the application of electrical energy from an outside source across an internal conductor or spark gap. An EED is generally a subassembly used to trigger a larger assembly.] [EED's have extensive military applications. They are used to activate certain control devices, to arm many various

ordnance items, and to initiate explosive trains. Examples are artillery/mortar proximity (variable time (VT)) fuzes, rocket motors, and electric blasting caps.)

Since the strength of the radiation decreases as the distance from the transmitter increases, the further away the ordnance item is, the less hazardous the situation. The energy can pass directly through materials that do not conduct electricity, such as wood or plastic. Therefore, using these materials as a barrier is of little value. The factors to be considered when evaluating the degree of hazard that the EMR (RF) energy represents are: (1) the strength of the field, that is, its power; (2) the nature of the frequencies transmitted; (3) the distance from the transmitter antenna to the ordnance, and; (4) the amount or type of protection available.

Hazards of Electromagnetic Radiation to Ordnance (HERO).

Some ordnance is particularly susceptible to EMR (RF) emission. This susceptibility is usually caused by the design of the ordnance item or the type of EED that is used. HERO categories have been established under which ordnance is classified as safe, susceptible, and unsafe. A knowledge of ordnance that is normally unsafe in the presence of EMR (RF) is important so that preventive steps can be taken if the ordnance is encountered in a suspected EMR (RF) field.

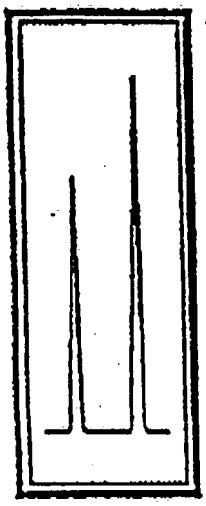
In general, all ordnance items, even those normally safe when intact, are hazardous when extensively damaged. The damage may expose components,

trailing wires, or breaks in shielding integrity that permit the entrance of EMR (RF) energy into the ordnance item and then into the EED.

The presence of antennas, communication and radar devices should be a point of interest on initial site visits and preliminary assessments.

APPENDIX B

SOIL GAS SURVEY PROCEDURES



TRACER RESEARCH CORPORATION

3855 North Business Center Drive
Tucson, Arizona 85705

1555 Park Avenue, Suite E
Emeryville, California 94662

1100 NW Loop 410, Suite 700
San Antonio, Texas 78213

5 Independence Way
Princeton, New Jersey 08540

STEPHANIE SQUARE
Avenue Louise, 65 Box 11
1050 Brussels, Belgium

Soil Gas Sampling Procedures

and

Quality Assurance

and

Quality Control Procedures

Table of Contents

SOIL GAS SAMPLING PROCEDURES

I. Probe Placement

A) A clean probe (3/4 inch galvanized steel pipe) is removed from the "clean" storage tube on top of the van.

B) The soil gas probe is placed in the jaws of a hydraulic pusher/puller mechanism.

C) A sampling drive point is inserted into the bottom of the probe.

D) The hydraulic pushing mechanism is used to push the probe into the ground.

E) If the pusher mechanism will not push the probe into the ground to a sufficient depth for sampling, a 30 pound hydraulic hammer is used to pound the probe into the ground.

II. Sample Extraction

A) An adaptor (Figure 1) is attached to the top of the soil gas probe.

B) A vacuum pump is hooked onto the adaptor via polyethylene tubing.

C) The vacuum pump is turned on and used to evacuate soil gas.

D) Evacuation is at least 30 seconds but never more than 5 minutes for samples having evacuation pressures less than 15 inches of mercury. Evacuation times are at least 1 minute, but no more than 5 minutes for probes reading greater than 15 inches of mercury.

E) Gauges on the vacuum pump are checked for inches of mercury.

1) Gauge must read at least 2 inches of mercury less than maximum vacuum to be extracting sufficient soil gas to collect a valid sample.

III. Sample Collection

A) With vacuum pump running, a hypodermic syringe needle attached to a 10 mL glass syringe is inserted through the silicone rubber, which acts as a seal, and down into the metal tubing of adaptor (Figure 1).

B) Gas samples only contact metal surfaces and never contact potentially sorbing materials (i.e., tubing, hose, pump diaphragm).

C) The syringe is purged with soil gas. Then, without removing the syringe needle from the adaptor, a 2 to 10 mL soil gas sample is collected.

D) The syringe and needle are removed from the adaptor and the end of the needle is plugged.

E) If necessary, a second 10 mL sample is collected using the same procedure.

IV. Deactivation of Sampling Apparatus

A) The vacuum pump is turned off and unhooked from the adaptor.

B) The adaptor is removed and stored.

C) Using the hydraulic puller mechanism, the probe is removed from the ground.

D) The probe is stored in the "dirty" probe tube on top of the van.

E) The probe hole is backfilled and capped, if required.

V. Log Book and U. S. EPA Field Sheet Notations For Sampling (Figures 2A-2D)

A) Time (military notation)

B) Sample number (use client's numbering system)

C) Location (approximate description - i.e., street names)

D) Sampling depth

E) Evacuation time before sampling

F) Inches of mercury on vacuum pump gauge

G) Probe and adaptor numbers

H) Number of sampling points used

I) Observations (i.e., ground conditions, concrete, asphalt, soil appearance, surface water, odors, vegetation, etc.)

J) Backfill procedure and materials, if used.

VI. Other Recordkeeping

A) Client-provided data sheets are filled out, if required

B) Sample location is marked on the site map

VII. Determination of Sampling Locations

A) Initial sample locations are determined by client (perhaps after consultation with *TRACER* personnel) prior to start of job.

B) Remaining sample locations may be determined by:

1) Client

a) Entire job sampling locations set up on grid system.

b) Client decides location of remaining sample locations based on results of initial study, or

2) Client and *TRACER* Personnel

a) Client and *TRACER* personnel decide location of remaining sample locations based on results of initial sample locations.

ANALYTICAL PROCEDURES

I. Varian 3300 Gas Chromatograph or Hewlett Packard 5890 Series II

A) Equipped with an Electron Capture Detector (ECD), a Flame Ionization Detector (FID), a Photo Ionization Detector (PID), and/or a Thermal Conductivity (TCD) Detector.

B) The chromatographic column used by *TRACER* for the analysis of halocarbons is a 1/8" diameter packed column containing Alltech OV-101. This nicely separates most of the tri-chloro and tetra-chloro compounds that are typically encountered during soil gas investigations. The di-chloro compounds tend to elute ahead of the tri-chloro and tetra-chloro compounds, thus creating no interference. In the event that assurance of the identity of a compound in any particular sample is required, it will be analyzed on a SP-1000 column after the OV-101 analysis.

II. Two Spectra Physics SP4270 or two 3396 Hewlett Packard Computing Integrators.

A) The integrators are used to plot the chromatogram and measure the size of the chromatographic peaks. The integrators compute and record the area of each peak. The peak areas are used directly to calculate contaminant concentrations.

III. Chemical Standards from ChemServices, Inc. of Westchester, Pennsylvania.

A) *TRACER* uses analytical standards that are pre-analyzed, of certified purities, and lot numbered for quality control assurance. Each vial is marked with an expiration date. All analytical standards are the highest grade available. Certified purities are typically 99 percent.

B) The Quality Assurance procedures used by ChemService were described by the Laboratory Supervisor, Dr. Lyle Phipher.

1) The primary measurement equipment at ChemServices, the analytical balance, is serviced by the Mettler Balance Company on an annual basis and recalibrated with NBS traceable weights.

2) All chemicals purchased for use in making the standards are checked for purity by means of gas chromatography using a thermal conductivity detector. Their chemicals are purified as needed.

3) The information on the purification and analysis of the standards is made available upon request for any item they ship when the item is identified by lot number. All standards and chemicals are shipped with their lot numbers printed on them. The standards used by *TRACER* are made up in a two-step dilution of the pure chemical furnished by ChemServices.

IV. Analytical Supplies

A) Sufficient 2cc and 10 cc glass Hamilton syringes so that none have to be reused without first being cleaned.

B) Disposable lab supplies, where appropriate.

C) Glassware to prepare aqueous standards.

D) Miscellaneous laboratory supplies.

I. Standards

A) A fresh aqueous standard is prepared each day. The standards are made by serial dilution.

1) First, a stock solution containing the standard in methanol is prepared at *TRACER*'s Tucson office. The stock solution is prepared by pipetting the pure chemical into 250 mL of methanol in a volumetric flask at room temperature. The absolute mass is determined from the product of volume and density calculated at room temperature. Hamilton microliter syringes, with a manufacturer's stated accuracy of plus or minus 1 percent, are used for pipetting. Information on density is obtained from the CRC Handbook of Physics and Chemistry. Once the stock solution is prepared, typically in concentration range of 50-4000 mg/L, a working standard is prepared in water each day. The solute in the stock solution has a strong affinity to remain in methanol so there is no need to refrigerate the stock solution. Additionally, the solute tends not to biodegrade or volatilize out of the stock solution.

2) The working standards are prepared in 40 mL VOA septum vials by diluting the appropriate μg/L quantity of the standard solution into 40 mL of water.

B) The standard water purity is verified each day before using it to prepare the aqueous standard.

C) The aqueous standard is prepared in a clean vial using a dedicated syringe each day.

D) Final dilution of the calibration standards are made in water in a VOA vial having a Teflon coated septum cap instead of a volumetric flask in order to have the standard in a container with no air exposure. The VOA bottle permits mixing of the standard solution and subsequent syringe sampling all day long without opening the bottle or exposing the standard to air. The measurement uncertainty inherent in the use of a VOA bottle instead of a volumetric flask is approximately plus or minus 1 percent.

E) The aqueous standard will contain the compounds of interest in the range of 5 to 400 μg/L depending on the detectability of the individual components. The standard will be analyzed at least three times at the beginning of each day to determine the mean response factor (RF) for each component (Figure 3). The standard will be injected again after every fifth sample to check detector response and chromatographic performance of the instrument throughout the day.

F) The RF allows conversion of peak areas into concentrations for the contaminants of interest. The RF used is changed if the standard response varies 25 percent. If the standard injections vary by more than 25 percent, the standard injections are repeated. If the mean of the two standard injections represents greater than 25 percent difference then a third standard is injected and a new RF is calculated from the three standard injections. A new calibration is started with the new RF's and calibration data.

$$\%\ of\ difference = \frac{A\ area - B\ area}{A\ area}$$

A = *mean peak area of standard injection first calibration*

B = *peak area of subsequent standard injection*

G) The low μg/L aqueous standards that are made fresh daily need not be refrigerated during the day because they do not change significantly in a 24-hour period. On numerous occasions, the unrefrigerated 24-hour old standards have been compared with fresh standards and no measurable difference has been affected. If the standards were made at high *ppm* levels in water, the problem of volatilization would probably be more pronounced in the absence of refrigeration.

H) Primary standards are kept in the vans and replaced every six months.

I) A client may provide analytical standards for additional calibration and verification.

II. Syringe Blanks

A) Each uL syringe is blanked before use.

B) 2 cc (glass) syringes are blanked if ambient air concentrations are elevated (greater than or equal to 0.01 μg/L) for components of interest.

C) If ambient air concentrations are $\mu g/L$ for components of interest, a representative sample of at least two syringes are blanked at the beginning of each day. If representative syringes have no detectable contamination remaining syringes need not be blanked. If any of representative syringes show contamination, all 2 cc syringes must be blanked prior to use.

D) Syringe blanks are run with air or nitrogen.

E) If it is necessary for any syringe to be used again before cleaning, it is blanked prior to its second use.

III. System Blanks

A) System blanks are ambient air drawn through the probe and complete sampling apparatus (probe adaptor and 10 cc syringe) and analyzed by the same procedure as a soil gas sample. The probe is above the ground.

B) One system blank is run at the beginning of each day and compared to a concurrently sampled air analyses.

C) A system blank is run before reusing any sampling system component.

IV. Ambient Air Samples

A) Ambient air samples are collected and analyzed a minimum of two times daily to monitor safety of the work environment and to establish site background concentrations, if any, for contaminants of interest.

B) All ambient air samples are documented (Figure 3).

V. Samples

A) All unknown samples are analyzed at least twice when injection times are less than 12 minutes.

B) More unknown samples are run until reproducibility is within 25 percent, computed as follows:

$$Difference = \frac{A - B}{(A + B)/2}$$

WHERE:
A is the first measurement result

B is second measurement result

If the difference is greater than .25, a subsequent sample will be run until two measurements are made that have a difference of .25 or less. Those two measurements are used in the final calculation for that sample.

C) The injection volume is adjusted so that mass of analyte is as near as possible to that which is contained in the standard, at least within a factor of ten.

D) Whenever possible, the attenuation for unknown samples is kept constant through the day (so as to provide a visual check of integrations).

E) A water plug is used as a gas seal in uL syringes.

F) A seal is established between syringes when subsampling.

G) At very high concentrations air dilutions are acceptable once concentration of contaminants in air have been established.

H) All sample analysis are documented (Figure 3).

I) Separate data sheets are used if chromatographic conditions change.

J) Everything is labeled in μg/L, mg/L, etc. PPM and PPB notations are to be avoided.

VI. Daily System Preparation (Figure 4).

A) Integrator parameters are initialized

1) Peak threshold

2) Attenuation

3) Peak markers

4) Auto zero

5) Baseline offset (min. 10% of full scale)

B) The baseline is checked for drift, noise, etc.

C) System parameters are set.

1) Gas flows (Note: N_2, air, H_2 tank pressure on Page 1 of chromatograms).

2) Temperatures

a) Injector

b) Column

c) Detector

D) After the last analysis of the day, used septa are rotated out of the injection ports and replaced with fresh septa.

E) Column and injector temperatures are increased to bake out residual contamination.

F) Syringes are cleaned each day

1) 2 and 10 cc syringes are cleaned with Alconox or equivalent detergent and brush.

2) uL syringes are cleaned daily with IPA or MeOH and purged with N_2. Syringe Kleen is used to remove metal deposits in the barrel.

3) Syringes are baked out overnight in the oven of the gas chromatograph at a minimum temperature of 60°C.

VII. Sample Splits

If desired, *TRACER*'s clients, or any party with the approval of *TRACER*'s client, may use sample splits to verify *TRACER*'s soil gas or groundwater sampling results.

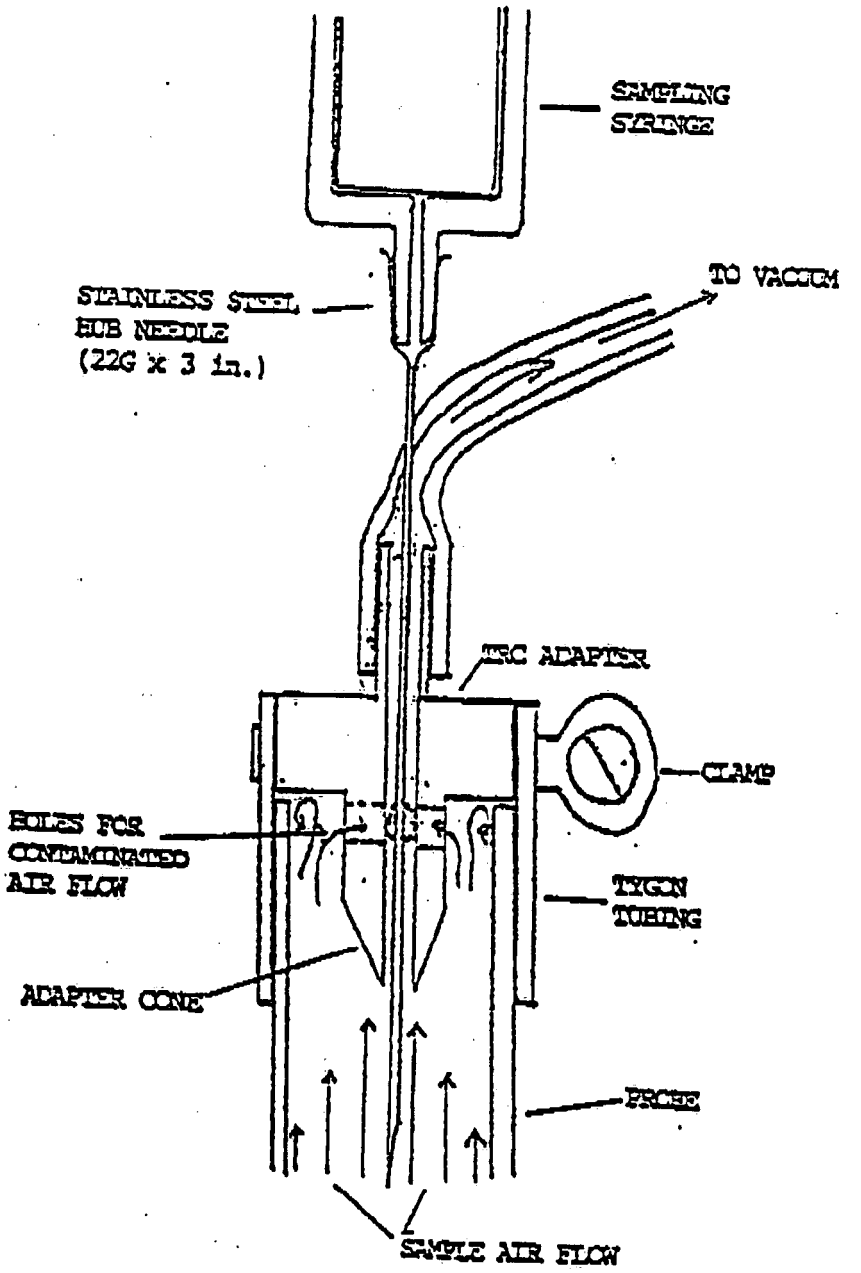
A) Sample splits may be collected in two-valve, flow-through-type, all-glass or internally electroplated stainless steel containers for analysis within 10 days of collection.

1) Flow through sample collection bottles are cleaned by purging with nitrogen at 100°C for at least 30 minutes. Once clean, the bottles should be stored filled with nitrogen at ambient pressure.

2) Sample bottles are filled by placing them in the sample stream between the probe and the vacuum pump. Five sample bottle volumes are drawn through the container before the final sample is collected. The sample should be at ambient pressure.

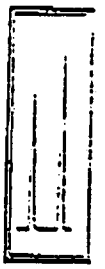
B) Sample splits can be provided in 10 cc glass syringes for immediate analysis in the field by the party requesting the sample splits.

C) Splits of the aqueous standards or the methanol standards used by *TRACER* for instrument calibration may be analyzed by the party requesting sample splits.



SCHEMATIC CROSS SECTION OF THE NEW TRC PROBE ADAPTER

FIGURE 1. SAMPLING APPARATUS



VAN # 1
PLATE # YEA-27M

SOIL GAS INVESTIGATION BACKGROUND INFORMATION

SITE NAME: DAVIDSON CHEMICAL
LOCATION: 14600 WEST AVENUE N. HAWTHORN SOUTH DAKOTA
DATES OF INVESTIGATION: 2/16 - 2/19/87
CLIENT NAME & ADDRESS: ROANOKE ENVIRONMENTAL
602 HARRISON RD
CHARLESTON SD 19627
FIELD REPRESENTATIVE(S) FOR CLIENT: TOM ANDERSON

PERSON TO WHOM REPORT AND QUESTIONS
SHOULD BE DIRECTED: SARAH WHEELER
PHONE: (737) 972-1003
CREW: CHEMIST S. CHARLES GEOLOGIST N. FARRINI

REPORT TO INCLUDE (CIRCLE):
(A) QA/QC-PROCEDURES-DATA ONLY or
B. FULL REPORT WITH CONTOUR MAPS AND INTERPRETATION

PURPOSE OF INVESTIGATION
DETERMINE EXTENT OF CONTAMINATION FROM STORAGE TANK FARM

SAMPLE

TARGET VOCs
TCA
TCE
PCE

GROUNDWATER INFORMATION:

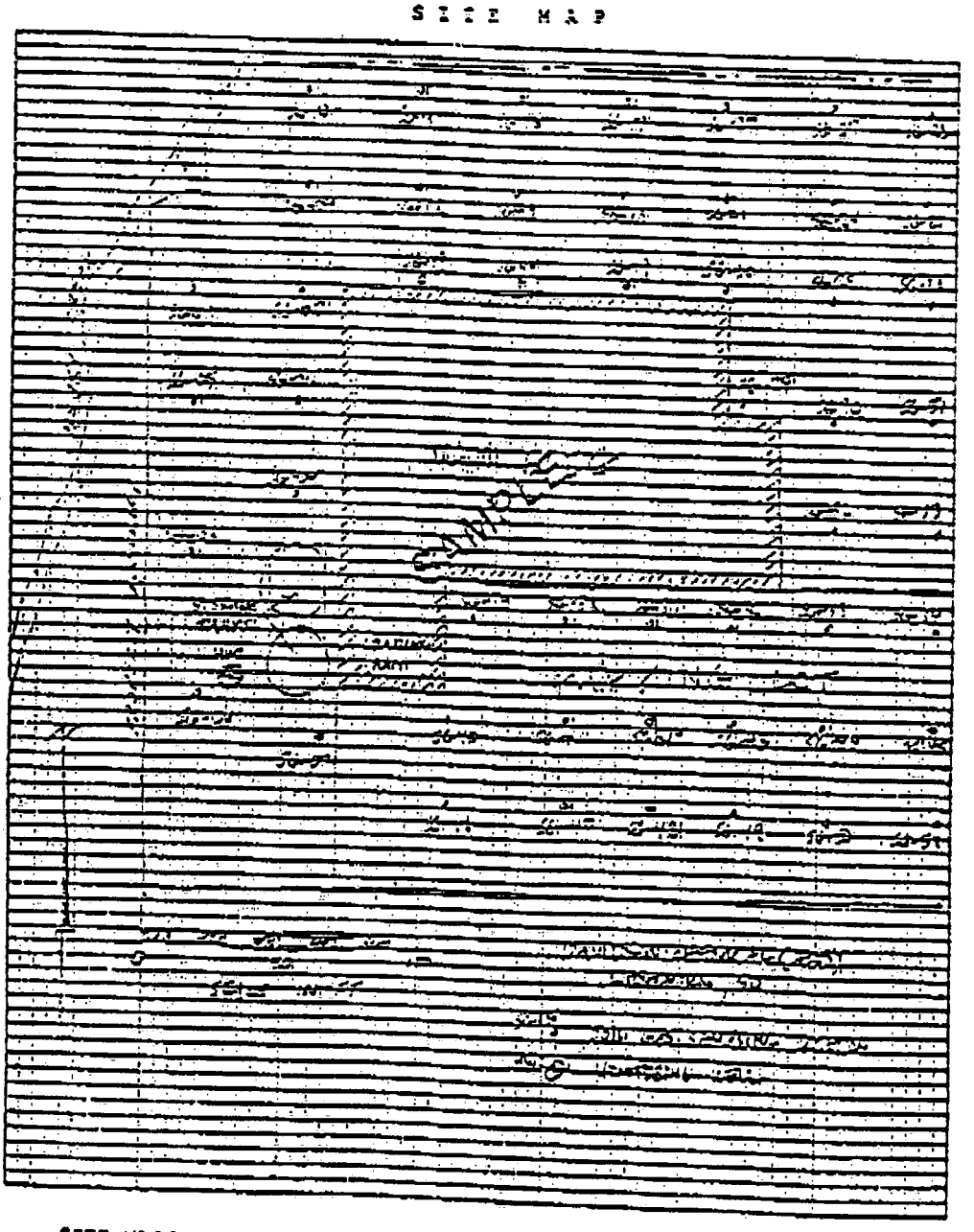
DEPTH TO WATER: 12-16' DIRECTION: NE

SOURCES OF CONTAMINATION
COMPANY USED SOLVENTS IN DEGREASING PROCESS IN MANUFACTURE OF ELECTRONIC CIRCUIT BOARDS. STORAGE TANK LEAKED AND LEAKED FROM APPROX 1970-1985 WHEN COMPANY SHUT DOWN. SOURCE WAS REMOVED IN 1986.

GEOLOGIC SETTING: (e.g. soil type, subsurface geology, etc.)
SAND & GRAVEL FILL (0-10'); WEATHERED BEDROCK 10'

FIGURE 2A
FIELD LOGBOOK - BACKGROUND INFORMATION

SITE MAP



SITE MAPS TO INCLUDE: SITE NAME, SCALE, NORTH ARROW, SOIL GAS LOCATIONS & NUMBERS, CULTURAL AND NATURAL FEATURES TO IDENTIFY

FIGURE 2B
FIELD LOGBOOK - SITE MAP

Tracer Research Corporation

DATE : 2-16-89
LOCATION : DAVIDSON CHEMICAL, SAVANNAH, GA
CLIENT : BRANDENBURG ENV.

GC Operator: S. CHARLES Field Assistant: M. FAVERONI
Weather : 12°F, SNOW SQUALLS, COLD & BLEEY

FIELD HOURS

A time on site : 0730
B time off site : 1730

Hours on site (B - A) : 10

Lunch hours : 1
Downtime hours[1] : 0
Standby hours[2] : 0

DECONTAMINATION

Probe Decontamination

Total hours: 1/4

Verified by GC operator

Syringe Decontamination

Total hours : 1/2

Verified by field assistant

DAILY SUMMARY

Calibration

Time start : 0730
Time end : 0830

Total hours: 1

Sampling

Max vacuum : 33 in Hg
Probes used : 18
Points used : 20
Soil gas samples collected : 18
Water samples collected : 0

Analysis

Total system blanks : 1
Total air samples : 3

Field data and gas standards checked by
Data checking hours: 1/2

1 - Downtime includes time spent repairing sampling & analytic equipment; note times and explanation on following field data pages
2 - Standby includes time available for sampling but waiting for client; note times and explanation on following field data pages

FIGURE 2C
FIELD LOGBOOK - DAILY SUMMARY

DATE: 2-16-89
LOCATION: DAVIDSON CHEMICAL, LAKEFIELD, SD CLIENT: BLASDELL ENV

SAMPLING DATA										
TIME	SAMPLE NUMBER	DEPTH	PROBE #	ADAPT #	PROBE PUSH/ POUND	VAC (in Hg)	EVAC TIME (s)	SAMPLE VOL (cc)	POINTS	NOTES/ADD'L DATA REQUESTED BY CLIENT
TIME ON SITE: 0730 BEGIN CALIBRATION: 0730										
0845	INTERV BLANK	NA	16	201	NA	5	30s	8	NA	
900	SC-01	6'	27	52	[illegible]	3	30s	9	1	TCE SIGNAL TIME ~25 SEC OF SAMPLING POINT. EVIDENCE OF LEAKS (CLAY IS DRY, FINE SAND TIGHT OVER AND SURFACE ON HEADING EAST ~50'E
915	SC-02	6'	301	16	[illegible]	5	30s	7½	1	ASPHALT REPAIR IS DESIGNED TO TAR CONTINUOUS SOFT AND PUTTY-LIKE IN APPEARANCE & FEEL; WAS ADDED TO SEAL, LEAKS NOTED THROUGH CRACKS, NOTED WITH TAPE
941	SC-10	5½'	15	10	[illegible]	4	30s	8	1	MADE TEE-PURGE ADJUST; CLIENT HAS INDICATED THAT WATER WON'T BE NECESSARY

SAMPLE

FIGURE 2D
FIELD LOGBOOK - SAMPLING DATA

TRACER RESEARCH CORPORATION
JOB- DAVIDSON CHEMICAL, LANTHORN, SOUTH DAKOTA
1 DATE- 16 FEBRUARY 1989
CHEMIST- S CHARLES
GEOLOGIST- M FAVEROU

DETECTOR A (0 or 1)
DETECTOR B (0 or 1)
RETENTION TIMES
SAMPLE INJECTION (uL)

	COMP 1	COMP 2	COMP 3
	1	1	1
	0	0	0
	0.78	1.1	1.7
	5	5	5
STANDARD CONCENTRATION (ug/L):	3 10	5	10
AREA RESPONSE 1:	95310	2000156	1140976
FROM INJECTION 2:	4 103683	1956743	1114123
3:	107190	2150570	1126570
RESPONSE FACTOR:	5 -4.90E-16	-1.23E-17	-1.13E-17
COMPONENT NAME	FIII 2	TCA	TCE

SAMPLE	TIME(A/B)	INJ A	INJ B	AREA	CONC.	MEMO	AREA	CONC.	MEMO	AREA	CONC.	MEMO
6		11			14							
H20 BLANK	755	5	12	ERR			ERR			ERR		
7 H2 IN AIR	800	1000		-1000	-0.09297	<0.1	-1000	-0.002405	<0.002	-1000	-0.000005	<.009
				-1000	-0.000040	<0.0005	-1000	-0.000001	<.00001	-1000	-0.000001	<.00001
AIR SAMPLE 8	825	1000		ERR			ERR			ERR		
SYSTEM BLANK 9	845	1000		2000	0.000979	0.001	4702	0.000057	.00006	12569	0.000036	0.0006
				2000	0.000979	0.001	5560	0.000068	.00007	10721	0.000124	0.0005
SG01-5'	911	1000		ERR			ERR			ERR		
SG01-5'	917	1000		15312	0.007515	0.008	5100	0.000006	.00007	351625	0.015580	0.02
10				17906	0.000011		5071	0.000072		410552	0.000160	
MS-18	955	1	13	ERR		15	ERR			ERR		
MS-18	1003	1		3421	1.677384	2	-1000	-0.01227	<0.01	40520	1.795490	2
				3650	1.700095		-1000	-0.01227		41715	1.970706	

FIGURE 3.
EXPLANATION OF FIELD DATA SHEET

1. Site and stock information.
4. Name of compound.
2. Concentration of analyte in calibration standards.
3. Peak areas obtained from standard injections during calibration.
5. Response factor (RF) for compound obtained from three calibration runs. The RFs are used for calculation of actual concentrations and are included on each data sheet.
6. Water blank verifies purity of standard water and cleanliness of injection system.
7. Nitrogen blank verifies decontamination of syringes and contaminant equip.
8. Air sample gives ambient concentrations for comparison with system blank.
9. System blank verifies decontamination of sampling equipment.
10. Sample id numbers, SG01-5' (soil gas sample 5 taken 5' below ground). MS-18 (water sample).
11. Time of analysis identifies the chromatogram from which the data was taken.
12. Amount of sample injection - used for concentration calculation.
13. Peak area - raw data produced by the computing integrator that is proportional to the mass of analyte in the sample.
14. Actual concentration present in the sample rounded to 2 significant figures.
15. Mean concentration of duplicate injections.

Tracer Research Corporation

Column OV-101
Length 7'
Dia. 1/8"
Liquid Phase OV-101
Wt. % 10
Support Chromosorb W
Mesh 80/90
Carrier Gas N2
Rotameter 30
Inlet Press 25 psig
Rate 30 ml/min
CHART SPEED 1
SAMPLE
Size
Operator

Detector ECD
Voltage 30 V
Sensit.
Flow Rates, ml/min
Hydrogen Air
Scavenge
Split
Temperature, °C
Det. 350
Column Initial 50 150
Final
Rate
Solvent
Conc.
Date

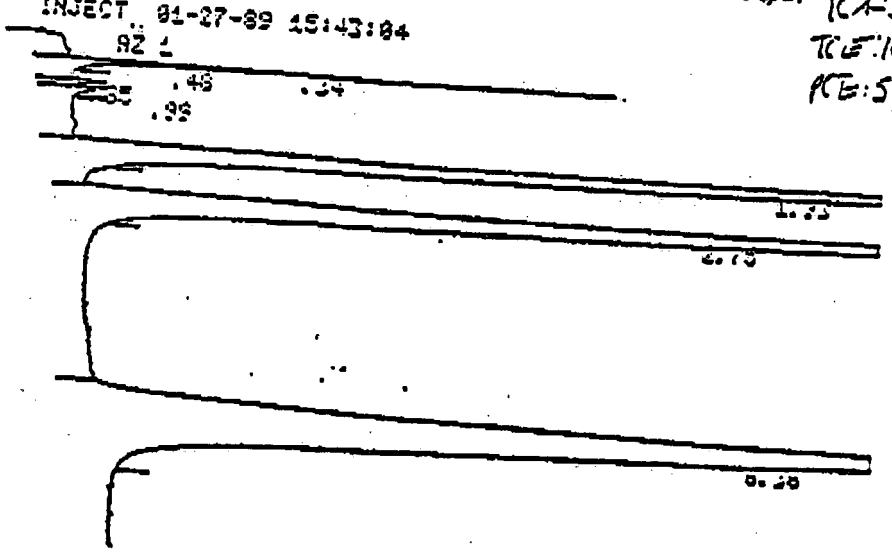
```
  READY
DATE " 01-27-89
TIME " 15:36
FI= 1.        FE= 1.        MN= 0.
PRESS 'ENTER' TO SKIP ENTRY
FILE NAME=" STD
TIME          FUNCTION   VALUE
TT= .01       TF=" AZ    TV= 1
TT= .01       TF=" FN    TV= 1
TT=

METHOD NUMBER:MN=

END OF DIALOG
AT= 32
OF=20
PT=1000

CHANNEL A
```

50°C STD 5µl
TCA-5
TCE:10
PCE:5
ng/L



8.6

STD

FILE 1. METHOD 0. RUN 1 01-27-89 15:43:04 CH= "A" PG= 1.
INDEX 1

PEAK#	AREA%	RT	AREA BC
1	0.377	0.34	13779 02
2	1.794	0.48	64194 03
3	0.164	0.85	6011 01
4	0.139	0.99	5047 01
5	25.081	1.33	917708 01
6	26.951	2.73	986147 01
7	45.921	8.26	1663623 01
TOTAL	100.		3656814

FIGURE 4
CHROMATOGRAM DOCUMENTATION